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Impact Assessment of Structural Interventions in Haor Ecosystem and Innovations for Solution

Volume III

Department of Bangladesh Haor and Wetlands Development
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Impact Assessment of Structural Interventions in Haor Ecosystem and Innovations for Solution

Field Report of BWDB Schemes

Volume III



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CEGIS

Center for Environmental and Geographic Information Services

This volume consists of field reports of following 10 BWDB schemes:

1. Chandra Sunarthal Haor System
2. Chaptir Haor System
3. Chayer Haor
4. Dhaleswai River
5. Halir Haor System
6. Humaipur Haor Project
7. Kalikota Haor Project
8. Re-excavation of Singua River
9. Surma River System
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Chandra Sunarthal Haor System

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1. Introduction

1.1 General Information

The Chandra Sunarthal Haor System is located in between 24°48' and 24°58' latitude and between 91°02' and 91°10' longitude. It falls under Dharmapasha Upazila of Suanamganj District. The project has a gross area of 6333.65 ha of which the Rivers and Khals occupy an area of about 24.72 ha. This Haor system is bounded by Dhankunia and Joydhona Haor in the northeast, Haizda embankment on the southwest and the Pagnar Haor in the eastern side. Joysree, Dakshin Sukair Rajapur and Dharmapasha unions are under this haor system. The Land slopes down from west to south side of the project area.

Water resource system of the Chandra Sunarthal Haor consists of important rivers such as Kangsa, Dhanu, Baulai and Konai River. The Konai River flows from north to east side of Chandra Sunarthal Haor while Kangsa River flows along the west side and gradually moves toward south. These two rivers meet together at Sreemantapur mauza and the joint course assumes the name as Dhanu river. There are a number of Khals and seasonal and perennial beels in the Haor. The important Khals in the project area are Saitan khali khal, Dubail khal, Sunarthal khal, Daulatpur khal, Chepi khal, Kalibari khal, Urisha khal and Moramanna khal. Besides khals, there are more than 10 (ten) beels of different sizes. The major beels are Dharam beel, Hargor beel, Kohuar beel, Harua beel, Kukrani beel, Dubail beel, Kainger beel, Sarda beel, Saitankhali beel, Sunarthal beel and Chatal beel.

1.2 Project Descriptions

Bangladesh Water Development Board (BWDB) implemented the Chandra Sunarthal Haor System Project during 1974-1978 with GOB fund. The main objective of the project was to protect Boro crops as well as to protect life and properties from early flash flood.The administrative and management control lies with Sunamganj BWDB O&M division under Sylhet BWDB Circle under the North Eastern Zone. The water management infrastructures of the Chandra Sunarthal Haor System Project include the following:

- 64 km embankment,
- 3 numbers of regulators
- 5 numbers of pipe sluices

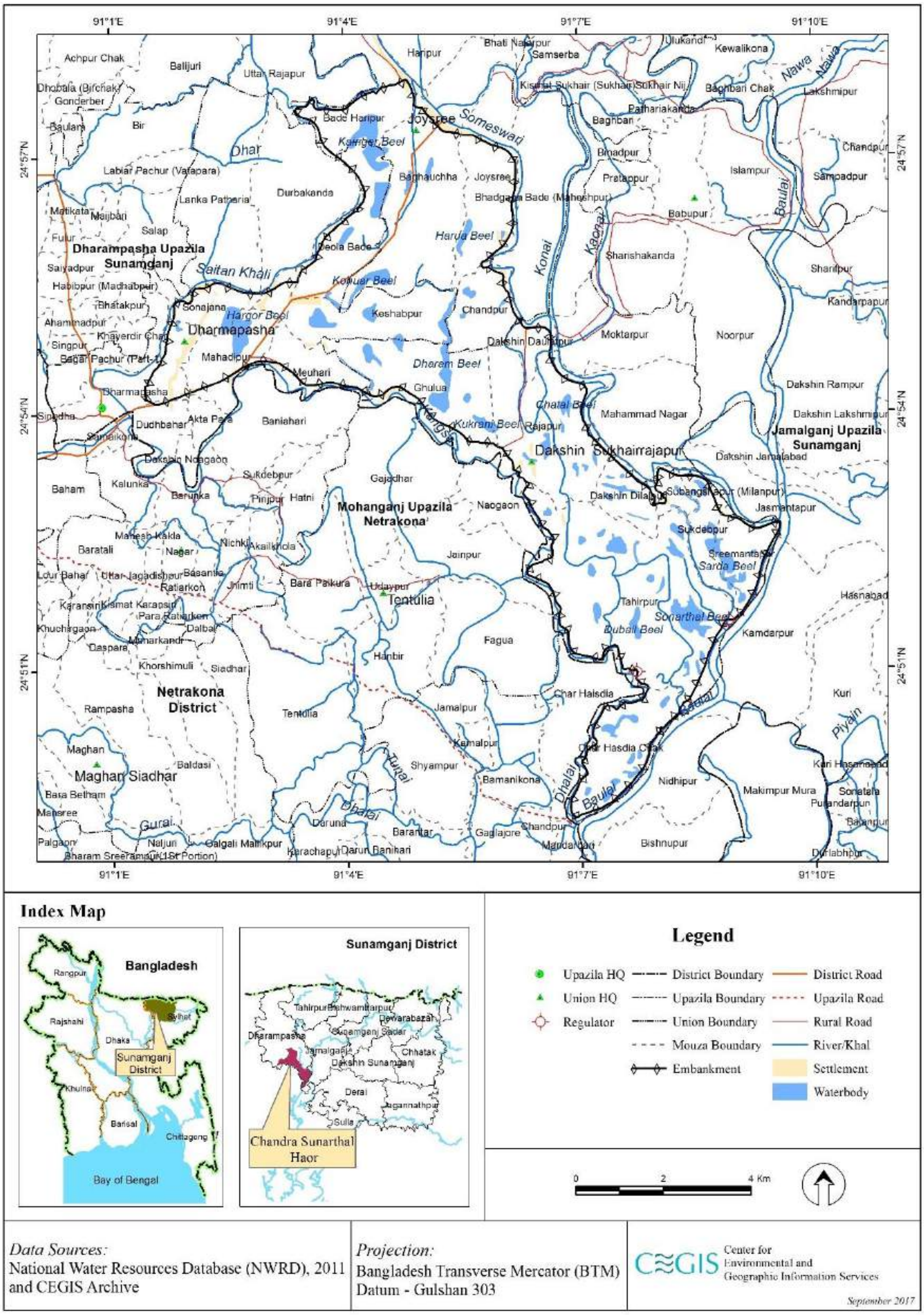

Figure 1.1: Hydrological features of Chandra Sunarthal Haor System

Boat Ghat at Mahadipur

Partial View of Dharam Beel

Boat Ghat at Jyosree

Navigation in Chandra Sunarthal Haor

Figure 1.2: Different features of Chandra Sunarthal Haor System

1.3 Present Status of the Project Interventions

Major interventions include submergible embankment with regulators in Char Haisdia and Sreemantapur. According to local people, the submersible embankments in Rajapur union breached almost every year in early monsoon. In addition, the regulators are not functioning properly due to heavy siltation.

2. Water Resources

2.1 Flooding

Pre Project

Before implementation of the project, flash flood frequently entered into the haor area through the Kangsa, Konai and the Baulai river during third week of April. Local people informed that the local stakeholder temporarily built embankment to protect their crops from flash flood. Besides, the conveyance capacity of the water bodies was more at that period. This activities were not systematic and sustainable as well as reliable to withstand the flash flood.

Post Project

With a view to saving the Boro crops from flash flood, BWDB constructed the submersible embankment and other structures in 1993. After construction of submersible embankment and regulators, entrance of flood into the project area got delayed by 2 (two) weeks. Thereafter, flood water enters in the Chandra Sunarthal Haor through Kangsha River, Konai river Saitankhali khal, Dubail khal and Ranokhali khal at the end of April or 1st week of May from southern side of the haor. Local people reported that there are several vulnerable locations of embankment within Ghulua-Rajapur-Daulatpur and Katakhali through which flood water also enters into the middle of the haor system. At sometimes, due to the flash flood, the water enters early into the haor which is supposed to inundate two weeks later. At present, the crest levels of the embankment at some locations like Ghulua, Durgapur, Rajapur werefound to be lower the design level. The peripeheralrivers of this haor system has been affected by sedimentation over the years that further exaggerates the problem of flash flood. Mentionable that some greedy people (not fishers) cut the embankment for fishing through the cuts which damages the Boro crops.

Impact

Interventions of the haor have delayed the entrance of flood water by two weeks. However, flash flood sometimes enters early due to delayed repairing of embankment and public cuts. People demanded to complete the O&M work within February to avoid the hazard of flash flood. Stakeholders of Dakhsin Sukhair Rajapur also opted for strong monitoring for operation and maintenance of the embankment.

2.2 Drainage

Pre Project

According to the local people, in pre-project period most of the water could smoothly be drained out through the Konai, Baulai and Baulai River. They did not face drainage congestion and water logging problem at large scale before implementation of the interventions.

Post Project

The flood water is being drained outt through the peripheral riversas well as through Dubail regulator, which is located in the southern side of the project area. Flood water in and around the northern portion of the haor drains out through Chanpur regulator into Konai River. There are some low lying areas in the southern part where drainage congestion occurs. Local people informed that 65% areas of Dakhsin Sukhair Rajapur Union faces water logging problem for about 15 to 20 days. Local people of Jyosree (upstream side) informed that they are not facing drainage congestion problem but the people of Sukhdebpur and Sreemantapur (downstream portion) are facing the problem because the Dubail regulator is not working properly. Water recedes slowly from the regulator due to sedimentation of the khals.

Impact

The drainage in the project area has been slowed down as well as impeded in the downstream area due to the interventions of the project.

2.3 Sedimentation

Pre Project

The sediment carried by the flash flood got deposited both in the rivers and haor area. Hence, sedimentation was not that much problem before implementation of the interventions.

Post Project

Normally sediment cannot enter in the haor due to embankment and get deposited in the outside rivers. However, sometimes sediment enters through the breached points and public cuts, if not repaired before pre-monsoon. Sediment also enters by breaching the embankment during severe floods. On the other hand, rapid siltation has taken place on the bed of Kangsa and Konai River.

Impact

Sedimentation has increased slightly compared to the pre-project condition.

2.4 Navigation

Pre Project

During pre-project period, there was navigational connectivity between the haor and the peripheral rivers throughout the year.

Post Project

Navigational connectivity between the haor and peripheral rivers like Kangsha, Konai and Baulai mainly remains operative during monsoon. Besides, navigation also operates through the breached points and public cuts before repairing in February/March. Moreover, boats can ply freely within the haor for fishing and other purposes. However, navigational connectivity does not persist during pre-monsoon due to repairing of submersible embankment.

Impact

The navigational connectivity has not been affected in monsoon but it does not operate during pre-monsoon.

3. Land Resources

The project area has fallen in one Agro-ecological zone, namely: Sylhet Basin (AEZ-21). Non-calcareous grey floodplain soil (non-saline) is the dominant soil. The top soil texture are clay and loam; where clay texture is dominant. The soils are slow permeable and have a medium moisture holding capacity. The land type characteristics are not uniform within the project area. About 87% of cultivable areas are low to very low land where minimum flooding depth is above 1.8 meter during the monsoon period. The recession of surface water from most of the agriculture land starts at middle of December and become free of flood water in late January.

Two indicators (Land use and Sand carpeting area) have been selected for assessing the impact on land resources due to structural interventions in Haor ecosystem. The land use and sand carpeting information under pre-project and existing situations were identified through analysis of the available archived satellite images of CEGIS and it was verified through Focus Group Discussion (FGD) and Key Informant Interview (KII).

Though the project has been completed during 1974-1978, assessment of land use change has been performed on the basis of available LandSAT image of 1989 and 2015 keeping in consideration that land use of 1989 represents the equivalent land use of earlier of project implementation.

3.1 Land Use

Pre Project

The project boundary has been considered as similar to post project. The gross area of the project was 6,334 hectare of which Net Cultivated Area (NCA) was 5,346 hectare. The rest area was covered with water bodies (perennial beels/haors, rivers and khals), forest and rural settlement area respectively. Details are presented in Table 3.1.

Post Project

Total gross area remaining same and the Net Cultivated Area (NCA) is 5,349 hectare. The rest area are covered with water bodies (perennial beels/haors, rivers and khals), forest and rural settlements including homestead vegetation. Details are presented in Table 3.1.

Impact

Net cultivated area and rural settlements including homestead vegetation has increased about 3 hectare and 29 hectare respectively while forest and water bodies have decreased about 11 and 16 hectare respectively. Detailed impacted area is presented in Table 3.1.

Table 3.1: Detailed land use in Chandra Sunarthal Haor System

Land use	Pre-project area(ha)	Post-project area(ha)	Impact (Post-project-Pre-project)
Net Cropped Area (NCA)	5,346	5,349	3
Water bodies	317	301	-16
Forest	551	540	-11
Rural Settlement	114	143	29
Total	**6,334**	**6,334**	**0**

Sources: Analysis 30 m Resolution Landsat Satellite Images, March: 1989 and 2015

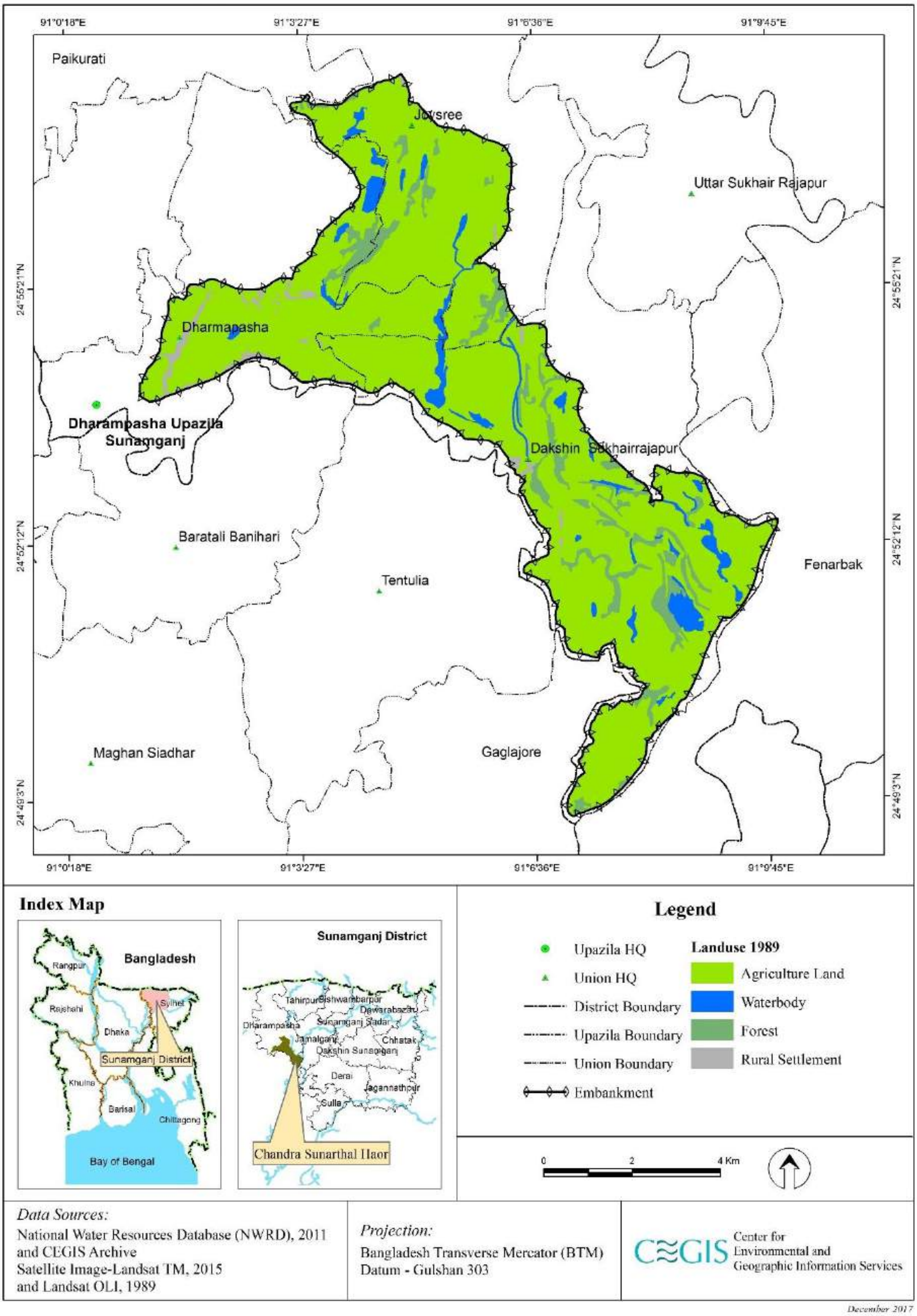

Figure 3.1: Land use of Chandra Sunarthal Haor System (1989)

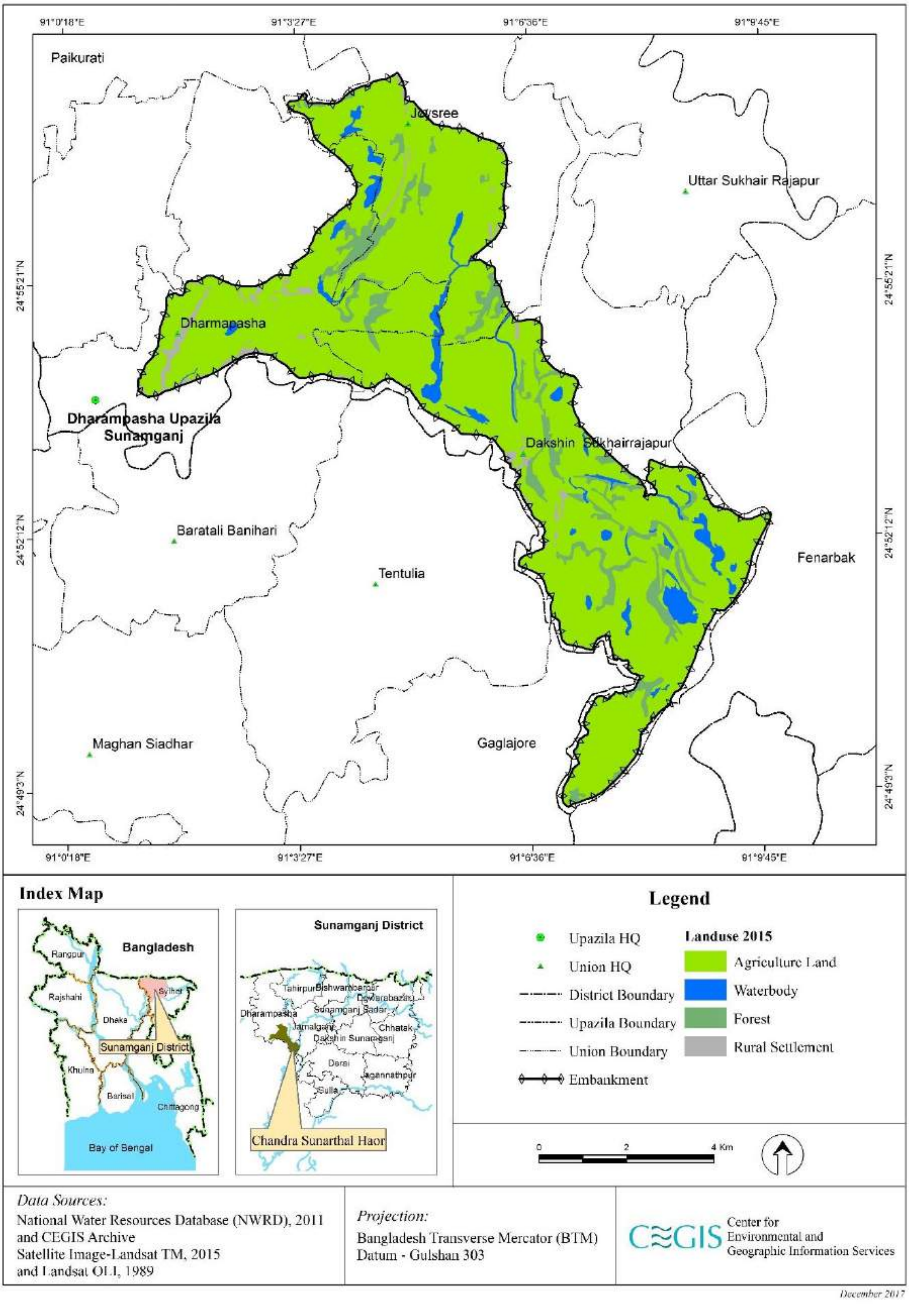

Figure 3.2: Land use of Chandra Sunarthal Haor System (1989)

3.2 Land Degradation

Pre Project

There was no sand carpeting in this condition.

Post Project

Sand carpeting observes at the location of Dilalpur, Rajapur and Tahirpur area.

Impact

Sand carpeting observes at the location of Dilalpur, Rajapur and Tahirpur area after implementation of the scheme.

4. Agriculture Resources

Boro rice is the main crop in Haor areas. In most cases, pre-matured or matured Boro crops are damaged by early flash flood which generally happened due to pre-monsoon heavy rainfall in the hilly areas. Besides, drainage congestion and irrigation water scarcity due to siltation of rivers, Khals and Beels are the another problem for Haor agriculture.

Six indicators (cropping intensity, crop area, crop production, crop damage, irrigation and use of agro-chemicals) have been selected for assessing the impact on agriculture resources due to structural interventions in Haor ecosystem. The information of these indicators were collected from both primary and secondary sources. The primary data were gathered from stakeholders through Focus Group Discussion (FGD) and Key Informant Interview (KII). The secondary data were collected from Bangladesh Bureau of Statistics (BBS) and field level Department of Agricultural Extension (DAE) office.

4.1 Cropped Area, Cropping Pattern and Intensity

Pre Project

Before the project interventions, the Net Cultivated Area (NCA) was 5,346 hectare, where dominant cropping pattern Fallow-Fallow-Local Boro was found. The land type of this project area was very low land (about 82%) followed by medium low land, low land and medium high land as presented in Table 4.1.

Farmers usually grew Local Boro crops in Rabi season. Different varieties of Boro rice such Gochi, Boro, Tepi Boro, Jagli Boro, Rata and Shail were very much popular among the farmers. According to the farmers, they couldn't cultivate 4% areas due to use as grazing land for livestock. Total cultivated area was covered with single cropped area. So, cropping intensity of this area was 96%. Detailed cropping pattern by land type under pre-project situation is presented in Table 4.1.

Table 4.1: Pre-project cropping pattern of Chandra Sunarthal Haor System

Land type	Kharif-I (March-June)	Kharif-II (July-October)	Rabi (November-February)	Area (ha)	% of NCA
Medium High Land(F_1)	Fallow	Fallow	Fallow	214	4
Medium Low Land(F_2)	Fallow	Fallow	Local Boro	481	9
Low Land(F_3)	Fallow	Fallow	Local Boro	267	5
Very low Land(F_4)	Fallow	Fallow	Local Boro	4,384	82
			Total	**5,346**	**100**
			Cropping intensity (%)	**96**	

Sources: CEGIS estimation based on field information and image analysis, September; 2017

Post Project

The project area became protected from early flash flood due to the interventions, which influence farmers to grow HYV Aman, HYV Boro, Hybrid Boro and Jute crops instead of Local Boro. HYV Aman, HYV Boro, Hybrid Boro crops also produces higher yield than local varieties. The most popular varieties which are used in the project area are: BR22, BRRI dhan32, BRRI dhan 28 and BRRI dhan 29, Hira, Aftab, ACI-5 and Mesta. The Net Cropped Area (NCA) has been decreased to 5,349 hectare after interventions. But, now 5,295 hectare area is under cultivation due to sand carpeting, water logging and irrigation problem observes in the project area.

Dominant cropping pattern of the project area is Fallow-Fallow-HYV Boro covering 95% of the NCA. The maximum cultivated area is covered with single and some double cropped area. So, cropping intensity of this area is increased, which is 107%. Detailed cropping pattern by land type under with project situation is presented in Table 4.2.

Table 4.2: Post-project cropping pattern of Chandra Sunarthal Haor System

Land type	Kharif-I (March-June)	Kharif-II (July-October)	Rabi (November-February)	Area (ha)	% of NCA
Medium High Land(F_1)	Jute	HYV Aman	Hybrid Boro	214	4
Medium Low Land(F_2)	Fallow	Fallow	HYV Boro	481	9
Low Land(F_3)	Fallow	Fallow	HYV Boro	267	5
Very low Land(F_4)	Fallow	Fallow	HYV Boro	4,333	81
	Fallow	Fallow	Fallow	54	1
			Total	**5,349**	**100**
			Cropping intensity (%)	**107**	

Sources: CEGIS estimation based on field information and image analysis, September; 2017

Figure 4.1: HYV Aman at Mahadipur maouza

Impact

The Net Cropped Area (NCA) has been increased to 3 hectare after interventions. On the other hand, total cropped area has been increased to 592 hectare. The cultivated area of Local Boro has gradually been decreased and replaced by HYV Aman, Hybrid Boro/HYV Boro and Jute crops after completion of project due to its higher yield rate and ensured early flash flood protection by project interventions. Impact on cropped area is presented in Table 4.3.

Table 4.3: Impact on cropped area in Chandra Sunarthal Haor System

Crop name	Pre-project Area (ha)	Post-project Area (ha)	Impact (Post-project-Pre-project)
HYV Aman	-	214	+214
HYV Boro	-	5,082	+5,082
Hybrid Boro	-	214	+214
Local Boro	5,132	-	-5,132
Jute	-	214	+214
Total	**5,132**	**5,724**	**+592**

Source: CEGIS estimation based on field information, September; 2017

4.2 Crop Production

Pre Project

The estimated total annual crop production of the project area was about 15,634 tons after loss of 2,958 tons before any interventions. Detailed crop production statistics before interventions is presented in Table 4.4.

Table 4.4: Annual crop production in Chandra Sunarthal Haor System under pre-project situation

Crop name	Total crop area(ha)	Damage Free Condition		Damaged Condition		Annual Production (ton)	Production Loss (ton)
		Area (ha)	Yield (ton/ha)	Area (ha)	Yield (ton/ha)		
Local Boro	5,132	3,849	3.6	1,283	1.3	15,634	2,958
Total	**5,132**	**3,849**	**-**	**1,283**	**-**	**15,634**	**2,958**

Source: CEGIS estimation based on field information, September; 2017

Post Project

After implementation of the project, hydrological regime of the project area is changed. Farmers started to cultivate HYV Aman, HYV/Hybrid Boro and Jute due to presence of submersible embankment, regulators and pipe sluice which protect their crops from early flash flood. Hence, total annual crop production is about 23,278 tons with loss of 6,623 tons after interventions. Detailed estimation of crop production after interventions is presented in Table 4.5.

Table 4.5: Annual crop production in Chandra Sunarthal Haor System under post-project situation

Crop Name	Total Crop Area(ha)	Post-project					
		Damage Free Condition		Damaged Condition		Annual Production (ton)	Production Loss (ton)
		Area (ha)	Yield (ton/ha)	Area (ha)	Yield (ton/ha)		
HYV Aman	214	214	3.1	-	-	663	-
HYV Boro	5,082	3,049	5.4	2,033	2.2	20,936	6,504
Hybrid Boro	214	182	6.2	32	2.5	1,208	119
Jute	214	214	2.2	-	-	471	-
Total	**5,724**	**3,659**	**-**	**2,065**	**-**	**23,278**	**6,623**

Source: CEGIS estimation based on field information, September; 2017

Impact

Additional 7,644 ton crops is being produced in post project situation. The rice production is increased due to the protection of flash flood which encourages the farmers for practicing high yielding variety instead of local variety. Detailed estimation of impact on crop production is presented in Table 4.6.

Table 4.6: Impact on crop production in Chandra Sunarthal Haor System

Crop Name	Pre-project Production (tons)	Post-project Production(tons)	Impact (Post-project-Pre-project)
HYV Aman	-	663	+663
HYV Boro	-	20,936	+20,936
Hybrid Boro	-	1,208	+1,208
Local Boro	15,634	-	-15,634
Jute	-	471	+471
Total	**15,634**	**23,278**	**7,644**

Source: CEGIS estimation based on field information, September; 2017

4.3 Crop Damage

Pre Project

Flash flood was the main cause of crop damage in pre-project situation. Before harvesting of Boro crop, water entered into the haor area and damaged the crops. So, farmer of this area suffered due to the damaging of their crops in every year. Total crop damage in the project area was 2,958 tons annually. Detailed estimation of crop damage is presented in Table 4.7.

Post Project

Chandra shunarthal haor is now protected from early flash flood by the project interventions which basically performed well up to 2012. After that, flood water enters into the project area before harvesting of Boro crop (early to mid-March) due to low height of submersible embankment and malfunctioning of structures through Kangsha River, Konai river Saitankhali khal, Dubail khal and Ranokhali khal at mid-April to end April and starts drain out in the month October. Local people reported that there are several vulnerable locations within the reach from Saitankhali to Kaizer embankment and near Dubail regulators; Maradia; Saitankhali; Amanipur village; western side of Maralpur village; southern side of the Milonpur village and Khatakhali bundh and floodwater also enters into the southern side of the project.

Every year BWDB closes the major breaches and entrances of the khal. The main reason for flooding in this Haor over the years is that the rivers have silted up and their water flowing capacities are gradually reducing. The excessive sedimentation makes rivers incapable of holding and conveying floodwater, which creates excessive pressure on earthen embankment. Moreover, plant height of HYV is less than local varieties and growing period of most of the HYV varieties are higher than local varieties except BRRI dhan 28. So, flood water affects the whole crop area at a time. The devastated flood that took place in 2004, fully damaged was paddy crops in about ninety percent of the cropped areas. In 2007, around 85% of the paddy crops were damaged. But, the situation was uncontrolled in 2017 and 100% Boro crops are damaged at pre-mature stage in the scheme area. Most vulnerable Mouzas such as Milonpur, Mahadipur, Saitankhali, Duabail, Mradia, Amanipur, Maralpur, Rajapur, Ghulua, Tahirpur, Sreemantopur, Sukdebpur, Joyosree, Kandipara, Chandpur and keshabpur are identified in this respect. Total crop damage is recorded as 3,575 ton after interventions. Detailed estimation of crop damage after interventions is presented in Table 4.7.

Impact

Though, the crop damage area has been increased from 25% to 40% after interventions. However, the crop damage has increased by 3,665 tons because the total production has increased significantly. The crop damage area is increasing day by day due to malfunctioning of the interventions and reduced water carrying as well as retention capacity of surrounding rivers, khals and beels. Detailed impact assessment on crop damage is presented in Table 4.7.

Table 4.7: Impact on crop damage in Chandra Sunarthal Haor System

Crop Name	Pre-project production loss (ton)	Post-project production loss (ton)	Impact (Post-project-Pre-project)
HYV Boro	-	6,504	+6,504
Hybrid Boro	-	119	+119
Local Boro	2,958	-	-2,958
Total	**2,958**	**6,623**	**+3,665**

Source: CEGIS estimation based on field information, September; 2017

4.4 Irrigation

Pre Project

Before initiation of the project, only surface water was used for irrigating Local Boro crops. The local people normally transplanted this crop immediately after the floodwater recedes and the land is under shallow inundation. Local farmer reported that they stored water with help of bundh/dyke management and irrigated their crop with the help of flooded water in the low lying part of the Haor. They also used traditional modes like *Seuti, Don and Cone* for irrigating their crop from surrounding rivers, Beels and Khals during dry season. Prior to the implementation of the project, irrigation water was more available than the requirement of crops.

Post Project

After implementation of the project, the irrigation water demand has been increased due to cultivation of high water demanding HYV Boro instead of Local Boro crop. On the other hand, the availability of surface water is being reduced due to siltation of surrounding rivers, khals and beels of the project area. Therefore, the scarcity of irrigation water has been observed from early February to end of March in most of the year. In this time, Kangsa River, the Dhanu River, and the Konai River), khals (Shaitankhali khal, Dubail khal, Sunarthal khal, Daulatpur khal and Moramanna khal) and beels (Dharam beel, Kurfine beel, Chadra beel, Choto beel, Mara Gang beel, Dubail beel, Kainza beel, Jabra beel, Saitankhali beel, Chandro Sunarthal beel and Kuri beel are the main source of surface water irrigation. Mainly Low Lift Pumps (LLPs) is being used for lifting surface water instead of traditional mode. In addition, about 5% of crop area is being irrigated from groundwater by using Deep Tube Wells (DTWs). The Khals ((Shaitankhali khal, Dubail khal, Sunarthal khal, Daulatpur khal and Moramanna khal) dried up in December-January and Beels(Kurfine beel, Choto beel, Mara Gang beel, Dubail beel, Kainza beel, Jabra beel, Saitankhali beel, Chandra Sunarthal beel and Kuri beel) are also dry up by bailing out of water in the month of December-January for harvesting fish.

Impact

There was deficit of irrigation water due to increase of water demand and decrease of water availability during dry season. The irrigation water demand has increased for cultivating high yielding crop variety. On the other hand, surface water irrigation availability has decreased due to siltation of rivers, khals and beels of the project area

4.5 Agro-Chemicals Use

Pre Project

Farmers of the project area cultivated only Local Boro in pre-project situation. They didn't apply agro-chemicals for crop cultivation. However, some farmers used inorganic fertilizer like mixed grass and rice straw in the crop field for the restoration of soil fertility.

Post Project

Generally more agro-chemicals are required for cultivating HYV Aman, HYV/Hybrid Boro and Jute crops. So, farmers applied more agro-chemicals for HYV Aman, HYV/Hybrid Boro and Jute crops cultivation. Total about 1,757 tons chemical fertilizers and 45 tons granular pesticides were used in the project area for crop cultivation per year. Detailed use of agro-chemicals under post-project situation is presented in Table 4.8.

Table 4.8: Use of agro-chemicals in Chandra Sunarthal Haor System under Post-project situation

Crop Name	Post-project					
	Fertilizer (kg/ha)			Total fertilizer(kg/ha)	Pesticides	
	Urea	TSP	MP		Liquid (ml/ha)	Gran. (kg/ha)
HYV Aman	110	60	30	200	-	5
HYV Boro	180	80	60	320	-	8
Hybrid Boro	210	90	60	360	-	10
Jute	50	-	-	50	-	-

Source: CEGIS estimation based on field information, September; 2017

Impact

Use of agro-chemical has increased largely under post-project situation compared to pre-project situation. Additional about 1,757 tons chemical fertilizers and 11 tons granular pesticides are used for crop cultivation annually. Detailed impact on use of agro-chemical is presented in Table 4.9.

Table 4.9: Impact on agro-chemicals in Chandra Sunarthal Haor System

Crop Name	Pre-project			Post-project			Impact		
	Total Fertilizer (ton)	Pesticides		Total Fertilizer (ton)	Pesticides		Total Fertilizer (ton)	Pesticides	
		Liquid (kilo litre)	Gran. (ton)		Liquid (kilo litre)	Gran. (ton)		Liquid (kilolitre)	Gran. (ton)
HYV Aman	-	-	-	43	-	1	43	-	1
HYV Boro		-	-	1,626	-	42	1,626	-	42
Hybrid Boro		-	-	77	-	2	77	-	2
Local Boro	-	-	-	-	-	-	-	-	-
Jute	-	-	-	11	-	-	11	-	-
Total		-	-	**1,757**	-	**45**	**1,757**	-	**45**

Source: CEGIS estimation based on field information, September; 2017

5. Livestock Resources

Livestock and poultry, being an essential element of integrated farming system, play an important role in the economy of the Haor area. Livestock provides significant draft power for cultivation, threshing and crushing of oil seeds; cow dung as a source of manure and fuel; a ready source of funds; and meat, milk and eggs for human consumption. A large number of livestock are reared in Haor areas but constrained by flash flood causing inundation of large areas during most of the time in the year. This area is famous for duck rearing due to availability of natural feed for ducks in natural large water bodies. All of livestock species suffer much due to shortage of feed, outbreak of waterborne diseases and inadequate shelter facilities. The livestock rearer in the Haor areas do not get fair price due to poor communication as well as lack of marketing facilities.

The indicator status of livestock has been selected for assessing the impact of the project. The status of livestock population data were collected from Livestock Census (1986), Agriculture census (1996 and 2008) of BBS. The status of livestock feed and fodder, diseases, marketing facilities information were gathered from stakeholders through Focus Group Discussion (FGD) and Key Informant Interview (KII).

5.1 Status of Livestock Population, Feed and Diseases

Pre Project

According to livestock census 1996, the livestock and poultry population in the project area were 3,150 cattle, 570 goats, 8,570 chicken and 6,540 ducks (Table 5.1). Before implementation of the project, the major feed available to ruminants was mostly crop residues (rice straw) supplemented with weeds from cultivated fields. They are to depend on naturally grown grasses in Kandas and alongside roads and embankments. Most of the year before implementation of the project, the crops were to damage by early flash flood. As a result, shortage of feed from crop residues, reduction of grazing facilities seriously affect livestock rearing. That time, the small holders were to depend on water hyacinth and other aquatic plant for their cattle. The major poultry feeds were rice bran, broken rice, kitchen wastes like rice, rice-gruel, vegetables, fish wastes etc. In addition, the duck usually scavenge in the nearby water bodies like Haor, beel, khal, river or any other low lying areas; mainly eat various types of aquatic insects, small fish, shell or snails. Major livestock and poultry diseases were Gola Phula (Haemorragic Septicemia), Pox and Cholera, Duck cholera, Newcastle and Fowl cholera etc. in the project area. The most vulnerable period was between July to November for spreading diseases to livestock and poultry populations. Mortality rate of the livestock/poultry was higher due to poor shelter condition and they lived in unhygienic condition. Marketing facilities was not in good condition and price was also low due to less demand of their products and by products. Producer consumed their products at family level and additional products were sold at local village market.

Table 5.1: Status of livestock/poultry in Chandra Sunarthal Haor System

Livestock/ Poultry Category	Pre-project		Post-project		Impact
	No of Households having Livestock	Total No of Livestock	No of Households having Livestock	Total No of Livestock	Number of Livestock Population
Cattle	820	3,150	1,930	6,580	3,430
Goat	270	570	330	720	150
Chicken	1,410	8,570	2,550	13,970	5,400
Duck	940	6,540	1,630	9,630	3,090

Sources: CEGIS estimation based on livestock census (1996), agriculture census (2008) and field information (September2017)

Figure 5.1: Cattle in the Rajapur mouza

Post Project

According to agriculture census 2008, the livestock and poultry population in the project area are 6,580 cattle, 720 goats, 13,970chicken and 9,630ducks (Table 5.1). After implementation of the project, crop is protected from early flash flood. As a result, the feed availability of livestock is increased due to increase of crop production. However, some of the year, the crops were damaged by early flash flood. In that year, the small holders were dependent on water hyacinth and other aquatic plant for their cattle. The poultry feeds are same as in pre project situation. On the other hand, more or less similar diseases are found in post project situation. The mortality rate of the livestock/poultry became negligible during the project period, due to extension works at farmers' level such as immunization and insemination program by Department of Livestock (DLS). Marketing facilities during dry season also improved due to improvement of the communication system by constructing the submersible embankments. Therefore, market prices are increased due to high demand of products and by products.

Impact

From 1996 to 2008, about 3,430 cattle have increased due to the reduction of flood vulnerability, improvement of marketing facilities and strengthening of livestock extension services. On the other hand, the goat, chicken and duck population has been increased to 150, 5,400 and 3,090 respectively. Details about impact on livestock are presented in Table 5.1.

6. Fisheries Resources

Chandra Sunarthal Haor system is bounded by a series of river system (mentioned in Water Resource Section) which act as the major water sources for maintaining sustainability of fish habitat. The Haor is fed by a number of connecting Khals including Shaitankhali Khal, Dubail Khal, Sunarthal Khal, Daulatpur Khal, and Moramanna Khal. The Haor possesses a large number of Beels (Kurfain Beel, Chadra Beel, Dubail Beel, Dharam Beel, Kainja Beel, Jabra Beel, Saitankhali Beel, Chandra Sunarthal Beel, etc.) the size of which vary from 2 to 63 ha. According to local people, Chadra Beel and Dharam Beel are the main fish breeding grounds of this Haor system. The field investigation revealed that the water centric interventions remotely control the hydrodynamic condition for fisheries resources of this Haor System.

6.1 Habitat Area

Pre Project

Fish habitat has been assessed from the landuse data that is extracted from the satellite image of 1989. The estimated total area of fish habitat of the Haor was about 5,669 ha where capture fishery was the sole contributor. There were some pits/ponds having no dike, inundated naturally. These ponds are considered under floodplain habitat. Floodplain shares the major part (about 94%) in the total habitat area followed by Beel and Khal. The breakdown of functionally different fish habitats of this Haor is given in Table 6.1.

Post Project

Similarly, the estimated fish habitat area has been assessed from the land use data, which extracted from satellite image of 2015, is about 5,670 ha. The increment of fish habitat area by about 23 ha, is contributed by the modest expansion of floodplain area of about 3 ha and newly created fish pond of about 20 ha. On the other hand, the decrement of fish habitat area by about 21 ha, is contributed by the loss of Khal area of about 5 ha, perennial Beel area of about 3 ha and Baor area of about 13 ha. The habitat area loss offsets the habitat area gain and thus the resultant net gain of habitat area is about 1 ha. The area of Baor was converted to extensive fish pond by 13 ha. The shrinkage of Khals occurs may be due to huge sedimentation (On an average annually 0.4-0.5m according to IEE report on 37 Haors) and encroachment for agricultural usage. The breakdown of functionally different fish habitats of this Haor is given in Table 6.1.

Table 6.1: Breakdown of fish habitat area by habitat type

<table>
<tr><th rowspan="2">Sl. No.</th><th rowspan="2">Habitat Category</th><th rowspan="2">Habitat Type</th><th colspan="2">Area (Ha)</th><th>Impact (Ha)</th></tr>
<tr><th>Pre-project, 1989</th><th>Post-project, 2015</th><th>(Habitat Area Change)</th></tr>
<tr><td>1</td><td rowspan="3">Capture Fishery</td><td>Channel/Khal</td><td>30</td><td>25</td><td>-5</td></tr>
<tr><td>2</td><td>Perennial Beel</td><td>195</td><td>192</td><td>-3</td></tr>
<tr><td>3</td><td>Floodplain</td><td>5,346</td><td>5,349</td><td>3</td></tr>
<tr><td>4</td><td rowspan="2">Culture</td><td>Baor</td><td>97</td><td>85</td><td>-13</td></tr>
<tr><td>5</td><td>Extensive Fish Pond</td><td>0</td><td>20</td><td>20</td></tr>
<tr><td colspan="3">Grand Total Area =</td><td>5,669</td><td>5,670</td><td>1</td></tr>
</table>

Source: Fish habitat assessment based on field findings and image based landuse data, 1989 & 2015.

Impact

The net gain of fish habitat area in the post-project condition is about 1 ha, which is negligible about 0.02% in compared to pre-project condition.

6.2 Habitat Condition

Pre Project

Floodplain was unregulated; timely entry of water into the Haor; silt carried by the rivers was dispersed over the Haor uniformly; river conveyance capacity was more. Local people opined that the Beels retained water in the dry season at a depth suitable for fishery. Among the Beels, Dharam Beel and Chadra Beel had an average depth of about 2-3 m during dry season. No Beel was dried up by bailing out of water in the month of December-January for harvesting fish.

Little better ecosystem was maintained with the exchange of pre-monsoon nutrients between river and Haor; new water breeding stimulation to the small indigenous species (SIS) of fish; higher breeding success; less natural and fishing mortality; rich biodiversity; more sustainable fish production, etc.

Post Project

Floodplain is regulated; floodwater enters into the Haor in the late pre-monsoon; silt deposited on the river bed as dispersion of silt is hindered or restricted by the submersible embankment; decreased river conveyance capacity. Local people opined that the Beels retained water in the dry season at a depth less suitable for fishery. This is happened may be due to wash out of loose soil of agriculture land and breached embankment along with river borne sediment. Other Beels are shallow and dry up by bailing out of water in the month of December-January for harvesting fish. However, among the Beels, Dharam Beel and Chadra Beel has an average depth of about 2-3 m during dry season as found in case of pre project condition.

Ecosystem is being degraded gradually but lightly as water control structures are not functioning properly. Exchange of pre-monsoon nutrients between river and Haor is being hindered or restricted to some extent by the submersible embankment; delayed new water entrance into the Haor and hampering breeding stimulation to the small indigenous species (SIS) of fish; in some cases egg deposited in the fish body; lower breeding success; little higher natural and fishing mortality; slightly declining trend in fish biodiversity; less sustainable fish production, etc.

Impact

The net physical condition of habitat is not significantly degraded and corresponding provisioning and supporting services of ecosystem including fish and fisheries. However, the changes in habitat suitability condition of rivers, Khals and Beels in terms of quantity and quality occurred more due to unconventional Beel fishery, illegal fishing, extensive use of agrochemicals and pesticides in paddy field, etc. rather than water centric interventions.

6.3 Fish Diversity

Pre Project

This Haor was rich in fish biodiversity containing more than 50 species (Table-A1 of Apendix A) in thepre project condition as some of the Beels are perennial and retained water at higher depths mentioned above suitable for fishery. The fish diversity particularly SIS was also facilitated by the unregulated lateral migration from river to Beel and Beel to river during pre-monsoon breeding season. Thus Beel resident fishes (particularly 'SIS') were dominant in the Beels and floodplain. Moreover, the abundance of shallow open water loving fish species (Chela- *Salmostoma bacaila,* Chapila- *Gudusia chapra,* Punti- *Puntius ticto,* Bajari Tengra-*Mystus tengara etc.)* were also more and evenly distributed in the whole Haor system. Major predatory fish species were known to inhabit include Boal- *Wallago attu*, Ayre- *Sperata aor*, Baghair-*Bagarius bagarius*, Shol- *Channa striatus*, Chital- *Chitala chitala*, etc.

Post Project

Fish species diversity has the declining trend but in slow pace in the Post Intervention condition. This is happening may be due to many factors other than water control structures. The factors include habitat loss (both depth and area) and shifting, water pollution, water regulatory structures, unplanned fisheries management and indiscriminate fishing e.g. use of harmful fishing appliances, catching of post larvae and brood fish, complete dewatering of leased water bodies for fishing, etc. In consequence of the above phenomena, following fish species become locally unavailable (for last 5-10 years) or have become rare includes Ayre (*Sperata aor*), Baghair (*Bagarius bagarius*), Shar Puti (*Puntius sarana*), Chital (*Chitala chitala*), Nanid (*Labeo nandina*), etc. Furthermore, open water loving fish (particularly Chela, Chapila, Tengra, etc.) species were evenly distributed regarding richness inside the total haor system as reported in case of pre project scenario. Among predator fish species, Boal (*Wallao attu*) had predominantly been increased in the haor area.

Impact

Comparing pre and post condition, it can be concluded that changes in fish species diversity and composition are not comprehensible in response to Project intervention. Whatever changes in species diversity and composition between two phases are observed may be posed due to other anthropogenic factors mentioned above.

6.4 Fish Migration

Pre Project

Local fishers stated that the lateral fish migration (early feeding and spawning migration rate, 15 April – 15 May, of riverine fishes, particularly 'Black' fishes) through natural connectivity was hindered by locally built earthen bund at the mouth of connecting Khals during both the pre-monsoon and post-monsoon period. Furthermore, most of the fries of riverine fishes enter the Beels and floodplain along with flood water. However, successful lateral migration of different fishes e.g., riverine carps, catfishes, etc. at their certain stages of lifecycle for food and residence is happening due to sufficient depths of the Beels.

Post Project

Pre-monsoon (15 April – 15 May) spawning/breeding migration of riverine (mainly the Kangsa and Konai Rivers) and Beel residence fishes through different connecting Khal is sometimes impeded due to the regulators at Alipur and Chandpur Village. Besides, riverine fishes migrate laterally to the Beels by overtopping or through breaching points of the existing embankment during flooding months of Jaisthya-Ashar (15 May–30 June). Lateral migration of different fishes, e.g., riverine carps, catfishes, etc. is being hampered due to insufficient depths of the Beels. Moreover, internal movement of 'SIS' of fishes is also being hampered through culverts (which are in the flood free road) due to high velocity barrier during monsoon.

Impact

Comparing pre and post conditions, it can be concluded that migration of SIS is impeded during the pre-monsoon in post condition and comprehensible impact has not been observed on fish migration in response to submersible embankment. Whereas major impacts were resolute due to other factors mentioned above.

6.5 Fish Production Assessment

Pre Project

The estimated total fish production was about 542 metric ton (MT) in 1989 where floodplain shared the most about 79% followed by Beel, Baor and Channel/Khal (Table 6.2).

Post Project

The estimated total fish production is about 2,113 metric ton (MT) in 2015 where floodplain shared the most about 89% followed by Beel, extensive fish pond and Channel/Khal. In the production assessment, the productivity of the corresponding year has been used.

Impact

Net increase in fish production in post condition is about 1,571 metric ton. As a whole, fish production has been increased by about 290%, whereas the increments of production from floodplain and perennial Beel are about 337% and about 135% respectively (Table 6.2). Such huge increment in productivity may be caused due to adoption of fisheries management like Beel fishery, increasing fishing activities, fishing commercialization, stocking of culture fish species in Beel and culture fishery, etc. Moreover, net gain of about 9 metric ton of fish comes from the conversion of Baor to extensive fish pond. The breakdown of fish productions is presented in the following Table 6.2 by functional unit of fish habitats.

Table 6.2: Breakdown of fish production by functional habitat

Sl. No	Habitat Category	Habitat Type	Production (MT)		Impact (MT)
			Pre-project, 1989	Post-project, 2015	[Production Change]
1	Capture	Channel/Khal	7	6	-1.26
2		Perennial Beel	88	207	119
3		Floodplain	428	1,872	1,444
4	Culture	Baor	19	0	-19
5		Extensive Fish Pond	0	28	28
Grand Total Area =			**542**	**2,113**	**1,571**

Source: Source: Fish production assessment based on field findings and FRSS data, 1989 & 2015.

6.6 Fishing Appliances

Pre Project

Different types of fishing appliances are used to catch fishes. The mostly used fishing appliances are: gill net, Kona Jal/Ghurni Jal/Ber Jal, push net, Khoira Jal, hook, Kironmala (one type of trap used to catch Guraicha- *Leander styliferus*), Gui (one type of trap used to catch small fishes), Sip etc. are used to catch other fishes. Furthermore, illegal fishing practice was reported during fishing in the leased Beel. Dried up the whole Beel for harvesting benthic fish species may be considered as a good example of illegal fishing. However, this type of fishing depends on the leasing rotation system.

Post Project

Leaseholders (LHs) generally use Katha as fish aggregating device (FAD) for fish. LHs usually harvest fish by three (3) years return in the months of February and March. However, another type of fishing pressure has been increased day by day around the water control structures. The local fishers (particularly part-time fishers) create barrier at the mouth of water control structure by net for catching fish. This fishing pressure becomes more prominent during recession of floodplain water in the post-monsoon season.

Impact

The scheme is not fully functional but still the water control structures are there. For this reason, some deviation in fishing activities is found in response to Project intervention. Fishing is done at each of the water control structures which were absent in the Pre Intervention condition. On the other hand, fishing pressure is also increased with the increasing of fish demand and fish supply chain for both the national and global fish market.

6.7 Fishers Livelihood

Pre Project

Field findings reveal that about 2% of the Haor populations were engaged directly and commercially in fishing and activities involved in fish supply chain for carrying out their livelihoods, referred as commercial fishers. There were no part-time and even subsistence level fishers. Commercial fishers spent annually about 180 days (6-8 hrs/day) in fishing.

Post Project

There is an increasing trend of fishing based livelihood, reported by local people in post project condition. However, no change in amount of commercial fishermen is reported in case of post project condition. Around 20 percent of the farmers change their occupation to fishing and fish trading seasonally. Commercial and subsistence level fishers spend annually about 290 days (8-10 hrs/day) and 180 days (6-8 hrs/day) respectively in fishing. They mainly catch fish in the open water area in and around the Haor for carrying out their livelihoods. Furthermore, a number of part-time fisher groups are evolved and increased day by day for fishing at the mouth of the connecting Khals where there are water control structures.

Impact

It can be concluded that the number of part-time and subsistence fishers are increased in response to the Project interventions.

6.8 Fisheries Management

Pre Project

Beel fisheries with leasing system were the prominent fisheries management as reported from the local people. All Beels were harvested by three-year rotation in the months of February and March. Beel fishery was more sustainable. However, there was no community based fisheries management in this Haor.

Post Project

Beel fisheries with leasing system are also the prominent fisheries management in the Post Intervention condition. Some Beels are harvested annually in the months of February and March. The whole Beel is used to dry up for catching benthic fish species. However, this type of fishing depends on the leasing rotation system of the Government. Beel fishery is becoming less sustainable. There is no community based fisheries management in this Haor and no enforcement at the indiscriminate fishing at the water control structures.

Impact

Rotation length of time for fishing in most of the leased Beels is decreased from three-year rotation to one-year rotation in the Post Intervention condition. Such over exploitation in conjunction with indiscriminate fishing at the water control structures is being happened mostly due to earn more money and driving fishery ecosystem into fragile resources.

7. Ecosystem

The Haor Basin in the north eastern part of Bangladesh is a wetland ecosystem considered to be of international ecological importance due to the extensive waterfowl population that uses the basin as its habitat. But its anaerobic conditions inhibit normal plant growth and only the plant groups known as hydrophytes which have adapted to thrive in such conditions. Chandra Sunarthal Haor, located in Netrokona district is one of the wetland ecosystems which support various types of ecosystems primarily terrestrial and aquatic. Terrestrial ecosystem belongs to different homesteads, kanda and roadside vegetations of the scattered settlement and their associated submergible roads. The remaining flora is aquatic life-forms. Similarly, a diversified fauna group along with aquatic species also occurs in this haor ecosystem.

7.1 Terrestrial Flora

Pre Project

Before intervention taken place, the study area was comprised of different terrestrial species but dominant tree species was naturally grown water resistant tree species. A few species that have the persistence to wave action like Hijol, Koroch, and Mera were common all over the haor. The settlement coverage of study area was about 114 ha of land. In homestead area the fruit yielding tree species was commonly found more than timber plants. Mango and banana tree was most popular fruit yielding tree among others. The bushy shrubs like Nolkhagra, Dholkolmi, different herbs and grasses were commonly found over the area. According to aged persons living in the area, the present vegetation coverage area is much higher than the past (before intervention) as homestead vegetation gradually increased over time.

Post Project

After the intervention taken place, the settlement vegetation has been increased about 1.5 ha area per year. Vegetation pattern has also been changed by introducing fast growing species and fruit yielding plant by local people. At present dominant terrestrial plant species of this area includes Euclayptas, Mahagoni, Raintree, Sirish, Narikel, and Banana etc. Local people plant Koroch and Dholkalmi as a fence to protect their homestead from heavy wave. Besides, Koroch and Dholkolmi plant is also used for fuelwood purpose throughout the whole area.

 

Source: CEGIS field visit 26 September, 2017

Figure 7.1: Settlement Vegetation Pattern at Chandpur village, Chandra Sunarthal Haor

Impact

The interventions like the construction of embankment, installation of regulator and improvement of drainage systems have paved the way to enhance the diversity of flora. But the population density and their daily needs are downing the current status. Access to more people to harvest natural resources as per demand has been leading depletion of terrestrial floral coverage due to overexploitation. Therefore, the ultimate goal of the interventions was dismay. The specific impact on flora has been depicted below in Table 7.1.

Table 7.1: Overall status of terrestrial flora of Chandra Sunarthal Haor

Sl. No.	Indicator Species	Pre-project	Post-project	Causes of status change/ Interventional linkage
	Flora			
1.	Pitali	Available	Medium	Use as fuelwood/Other purposes
2.	Hizal	High	Less	Over extraction/use as fuelwood
3.	Koroch	High	Less	Over extraction/use as fuelwood
4.	Baroon	Medium	Less	N/A
5.	DholKolmi	Available	Available	N/A
6.	Nol Khagra	Medium	Less	N/A

7.2 Terrestrial Fauna

Pre Project

Terrestrial vegetation was the shelter and roosted place for different bird species especially Pallas's Fish Eagle, Brahminy Kite, Black Kite and other common birds. During winter, Jackal, Big rat were frequently seen along crop field and bushy high land of the haor. South-western part of Chandra Sunarthal haor area was favorable place for medium sized mammals like fishing cat, jackal and other wildlife. According to local old people, otter was seen inside the haor area. The reptiles and amphibians population was also found good in number.

Post Project

At the post-intervention period, the terrestrial faunal status had been declining for decades. Most of the dominant terrestrial fauna turned into threatened category those were available due to different anthropogenic activities. After implementation of interventions, it had paved the way to produce more crops instead of keeping lands unproductive. In this context, the fallow land/kandas and other swamp forest had been converted into agricultural land to produce rice. As a consequence, terrestrial fauna lost their suitable habitats where they build nests, groom for breeding and take parental care to their offspring. But commonly available terrestrial birds like Black Drongo, Common Myna, Asian Pied Starling, Oriental Magpie Robin, Spotted Dove, Red-vented Bulbul, House Sparrow, Common Tailorbird, etc. has been sighted good in number and their population remains almost similar in comparing pre-intervention period. Among the reptiles, the Indian Rat Snake, checkered Keelback, Common Garden Lizard, House Lizard, Skink, Bengal Monitor, are reported to be commonly found in the area. The amphibians inhabit in various habitats from human settlement to agricultural lands and even in ditches. The frog and toad species those are commonly observed in the area are Common Toad, Indian Bullfrog, and Cricket Frog etc. Two mammalian species i.e. Otter and Fishing cats are not commonly seen in this Haor (source: local people) which was available 30 years ago in substantial number.

Source: CEGIS field visit 26 September, 2017

Figure 7.2: Balck kite nest at mobile tower in Rajapur village

Impact

The facilities provided by the intervention namely embankment, sluice gate, regulators, etc has given the opportunity to other sectors for harvesting best service but it has been indirectly triggered fauna into diminishing to the threat of extinction. Additionally, human population growth of the haor area is increasing. Therefore over extraction of fisheries resources and fuelwood causing food shortage and habitat loss that is ultimately harmful for wildlife. A specific status of the terrestrial fauna is presented in Table 7.2

Table 7.2: Status of the terrestrial fauna of Chandra Sunarthal Haor

Sl. No.	Indicator Species	Pre-project	Post-project	Causes of status change/ Interventional linkage
		Fauna		
1.	Pallas's Fish Eagle	Less	Not seen	Food and habitat loss
2.	Brahminy kite	Medium	Medium	N/A
3.	Snail	High	Medium	Duck cultivation, over extraction
4.	Black kite	medium	Less	Food shortage/ Habitat loss
5.	Vulture	Medium	Not seen	N/A
6.	Rat snake	Medium	Less	Killing/Habitat loss
7.	Fishing Cat	Less	Not seen	Food and habitat loss

7.3 Aquatic Flora

Pre Project

The sample respondents (those who can recall the haor scenario before intervention taken place) opines that, the aquatic bodies were full of different floral groups especially in Dharam beel,Sunarthal beel, Harua beel, Kukrani beel, Chatal beel, Kainger Beel and Konuar beel. These were also important perennial wetlands of the haor and served as the main source of irrigation and fish habitat during dry season. In fact the total Chandra Sunarthal haor area was open without any interventions. The floral vegetation like water hyacinth and waterlily were with abundant because most of the land was fallow and not used for cultivation. Sometimes, flash floods occurred and made damaged to many floral communities. The diversity of flora in this haor area was good compare to current status. Additionally, the floral density was also standard in this haor ecosystem.

Post Project

After the intervention, the floral diversity lessened for different anthropogenic activities. Present use of pesticides and fished methods causing harm towards the aquatic flora. Over extraction of floating, rooted or deeply rooted plants; causing threat for the diversity of this floral community. Major free floating plants found within the study area are: *Azolla pinnata, Eichhornia crassipes, Lemna perpusilla, Pistia stratiotes, and Salvinia cucullata.* A number of submerged and attached floating plants exist in this haor but lower in number considering the pre-intervention period according to the sample respondents.

Source: CEGIS field visit 25th & 26th September, 2017

Figure 7.3: Aquatic flora in Chandra Sunarthal Haor

Impact

The interventions for raising crop productivity have a major impact on aquatic flora throughout the haor area. Some species has lost its richness and received threats to its survival namely Water Lilly, Makhna, and Chhaila Grass. The Following Table represents the status of indicator aquatic plant species of the haor and their impacts over the time

Table 7.3: Status of aquatic flora of the study area

Sl. No.	Indicator Species	Pre-project	Post-project	Causes of status change/ Interventional linkage
	Flora			
1.	Kochuripana	Medium	Less	Use as a fodder
2.	Shapla	High	Less	Over extraction
3.	Makhna	Medium	Less	Over extraction
4.	Singra	High	Not seen	Over extraction
5.	Chailla Ghash	High	Less	Excess use in wave protection purpose/pesticide uses/Over extraction

7.4 Aquatic Fauna

Pre Project

Before intervention taken place, Chandra Sunarthal Haor was rich in aquatic faunal resources comparing present condition. The varied number of fish's species was linked with a complex network of food web in the entire ecosystem. Sona beel and Dubail beel was most favourable place for winter visiting migratory birds. Water dependant common resident bird species i.e Indian Pond Heron, Little Egret, Common Kingfisher, Little Cormorant, different duck species etc. was commonly found all over haor wetlands especially in dubail beel.

Post Project

It is evident after field visit that, considering the before project scenario the number and diversity of aquatic fauna has been decreased over time. The number of mammalians, birds, amphibians and reptiles all are dropped down gradually for different factors. As per the sample respondents, now migratory bird species are visiting only few spots of the total haor area and the resident aquatic birds are not seen frequently. Current status of bullfrog and turtle decreases over time due to hunting and death from fishing nets.

Impact

The interventions was build for rising up crop production rate that ultimately decreased feeding habitat of aquatic fauna as rice cultivation even taken place in the floodplains, beels and other low lands. In addition, the generated noise from tractors and other cultivation machinery made disturbance to waders throughout the area. The hunting pressure also can be mentioned as disturbance to avoid the feeding ground by the birds. Moreover, the present pesticide use methods in the paddy field have caused negative impact on the population of the aquatic fauna. Due to the implementation of interventions throughout the haor it triggers the diminishing of their population as well as diversity for decades.

Table 7.4: Aquatic fauna status of the haor

Sl. No.	Indicator Species	Pre-project	Post-project	Causes of status change/ Interventional linkage
Fauna				
1.	Bull frog	Medium	Less	Killing/Improper insecticide use
2.	Cricket frog	High	Medium	N/A
3.	Checkered Keelback	Medium	Less	Killing/ habitat loss
4.	Otter	Not seen	Not seen	food and habitat loss
5.	Migratory bird	High	less	Hunting/food scarcity/Human Disturbance and habitat loss
6.	Egrets/Herons	High	Less	Human disturbance/Trapping
7.	Turtles	high	Less	Hunting/damage habitat

7.5 Swamp Forest and Reed Land

Pre Project

A good number of swamp forests and Reedlands were occurred inside the haor for long decades especially in Rajapur and Mahadipur village. The composition of reedlands is Baro Nol (*Arundo donax*), Khagra (*Phragmites karka*), Murta (*Schumannianthus dichotomous*), Chitki (*Phyllanthus disticha*), etc. The forest density supported different faunal species. In addition, the kandas of the beel also been occupied with different reeds and associated jungles for a long time. The reed lands provided habitats to different wildlife species for nesting and roosting for a while. It also provided core habitats to wildlife in this haor region.

Figure 7.4: Swamp forest at Rajapur village (24°53'47.94"N, 91° 6'26.22"E)

Post Project

Currently this haor area consists of swamp forest in some areas namely Rajapur and Mahadipur village area. The total number of swamp forest tree has been reduced over time. The forest becomes very rare due to clearing, cutting and other anthropologic activities. The reed beds have also been severely reduced because of continued over harvesting for fuel and converting land into vegetable stand. Due to undulating land pattern some area face early water logging problem and remain as a fallow land at Dubail and Doelpara area. The existing reed land and swamp forests is supporting in local biodiversity enhancement and good earning source for the haor inhabitants.

Source: CEGIS field visit 25 September, 2017

Figure 7.5: Koroch bagh at Rajapur village

Figure 7.6: Hijal Bagh at Mahadipur Village

Impact

Degradation of the conditions of swamp forest and reed beds has lead to several impacts on resource use and livelihood of the local people. Swamp forest and reeds bed used to act as a good shelter and feeding ground for aquatic fauna, birds including fish. Thus degrading swamp forests for anthropogenic causes leading indirect effect on fish dependant bird and other wildlife resulting food crisis. Intervention may suspect to the siltation in the haor area but has no direct relation with the effect of swamp forest and reed land regeneration. Conversion of reedland for agricultural expansion is only considered indirect impact regarding this issue.

7.6 Ecosystem Goods and Services

Pre Project

The ecosystem goods are fertilizer, food, medicine, energy, fiber, construction and craft material. On the other hand, the ecosystem services have been divided into four categories on the basis of their nature of functions and they are provisioning, regulating, supporting and cultural services. In this stage, the goods and services had not interrupted by any interventions and these were improved naturally. The provisioning services in this area had been considered as food, medicinal plants and genetic resources of the flora and fauna had been standard before implementation of the interventions. Regulating services such as climatic condition was good because of vast coverage of natural vegetation. Wetland function was good due to absent of different types of physical structures. In addition, the cultural services like spiritual, religious, and recreational and ecotourism, aesthetic, educational and cultural heritage also be considered as optimum.

Post Project

The provisioning services have been changing day by day due to the implementation of interventions throughout the haor area. The change implies rice variety changes from local to HYV and the introduction of other vegetations which occupied largely throughout the haor area. The regulating services also interrupted via climatic change while wetland function and habitat became worse. The cultural services have also been changed. It practices tourism instead of ecotourism and hampering the aesthetic value of the haor area.

Figure 7.7: Duck cultivation at Chandra Sunarthal Haor

Figure 7.8: Water Hyacinth use as fodder at Chandra Sunarthal Haor

Impact

Of the above-mentioned changes in three ecosystem services played negative role in food, medicinal vegetation and diversity, and population of flora and fauna of the depicted haor area. Similarly, unplanned tourism establishment, also an event, occurs within the haor ecosystem. No direct link with the intervention has been evident during the study.

8. Socio-economic Conditions

8.1 Introduction

The Haor system provides a wide range of economic and non-economic benefits to the local people as well as other people of Bangladesh. These include benefits in terms of rice production, fish production, cattle and buffalo rearing, duck rearing, collection of reeds and grasses, collection of aquatic and other plants. This study was conducted at Chandra Shonarthal Haor area. The socio–economic picture was explored in this section to understand both before and after project people’s condition using both primary and secondary data in relation to the the objectives of the study.

8.2 Location and Demography

The Chandra Shonarthal Haor is located at the Dharmapasha and Jamalganj Upazila of Shunamganj district. In Dharmapasha upazilla, there are nine (23) mouzas under the 3 unions and one Mouza under Fenarbak union of Jamalganj upazilla.

The study area was composed of about 4299 households with a total population of 25102 of which 13082 are male and 12020 are female. At present about 7561 households are living in this area with a total population of 37807 of which 17721 are male and 17687 are female. It is observed that the female population is slightly lower than the male population in both scenarios. Before intervention the average male-female sex ratio was 105 whereas the present sex ratio is 102. The average density of the area has also changed with the increase of population. The average density of the population has changed to 385 from 331 persons per sq. km. The demographic features of this area is presented in the following **Table 8.1** based on Bangladesh population and housing census 1991, 2011 and projected population in 2017.

Table 8.1: Distribution of population and household in the study area

Time	Household	Population	Sex ration	Density
Before Intervention (1991)	4299	25102	105	331
Present (projected, 2017)	7561	37807	102	385

Source: Bangladesh Population and Housing Census 1991 & 2011 and projected up to 2017.

8.3 Livelihood Status

Pre Project

Before the project intervention the majority of the households about 85 % were directly dependent on agriculture as the main source of income with about 35% on cultivation/share cropping and about 50% as agricultural labourer. Furthermore, during the field visit it was also found that the occupational groups and occupational patterns are characterized by the land holding category and seasonal variation. Normally, the large farmer (3.036 ha and above ha) and medium land owners (1.012 – 3.032 ha) did not engage themselves in any other secondary occupation for their livelihood. But the landless and the small farmers were bound to engage themselves in many other secondary occupations with seasonal changes. Before intervention fishery and business were the second dominant occupational group for earning their livelihood (5%). Other sources of income were service and transport.

Post Project

The occupational scenario has been changed in course of time. At present, it is observed that about 75% of the population are directly or indirectly dependent on agriculture. During the field visit it was also found that agriculture is the primary source of livelihood for 15% of the households. Another 35 % are employed as wage labourers on other farms and rest 25% of the household are involved both in farming as well as in other occupation like wage labour. Besides, at present about 5% have permanently migrated from the area at different parts of the country for better income and livelihood. There also some seasonal migration was found in the study area both in terms of out migration mainly in garments sector (5%) and occupational migration especially in fishing (15%) due to continuous loss in agriculture. Mainly the agricultural and non-agricultural labourers are these migrants. On the other hand peoples of the area are gaining their livelihood from business, non-agricultural labour, service and transport.

Impact

Agriculture is the main sources of income so far and the agricultural production is increasing in Chandra Shonarthal Haor. Income opportunity based on fishing has declined and only some people from fishing community got access only to do work as a seasonal labor in this particular area. Due to leasing arrangements, which are often controlled by local elites, result in highly restricted access to open water fisheries by the poor.

8.4 Land Ownership

Pre Project

During field visit it was recorded from local stakeholders that about 33% of the households are absolute landless (i.e., having no lands either homestead or cultivated), 35% households belong to functional landless and marginal farmer (0.004 – 0.198 ha) category (i.e., having only homestead lands, cultivate predominantly by housewives mainly for household consumption), 12% households belong to small farmer (0.202 - 1.008 ha), 5% belong to medium farmer (1.012 – 3.032 ha) and 15% belong to large farmer (3.036 ha and above ha) categories.

Post Project

Land holding category has changed in the post-project condition. There are some autonomous factors like population growth and distribution of property through inheritance playing the major roles in the changes of land ownership. Besides, after the project intervention the functional landless group and the small farmers gain some new lands with the increase of income through higher production of rice and income from other income generating activities like fishing, non-agricultural labor etc. At present, the ratio of land holding category is as follows: absolute landless households 15%, functional landless 20%, small farmer 35%, medium farmer 27% and 3% belong to large farmer category.

Impact

As stated earlier, in course of time, the income sources of the people of Chandrashonarthal Haor Project area have been changed. Employment opportunities have been created inside and outside of the Haor. After the intervention, the cropped area has increased in terms of more intensity and area by releasing land from inundation through drainage congestion. The released land has been brought under cultivation. After the intervention, the crop production has also increased due to the practice of high yielding crop variety using land protected from inundation of flash flood. The overall income of the farmers has, thus, increased and affordability for a better living standard is achieved.

8.5 Accessibility in Education and Health

Pre Project

Before intervention, the health and education services for the people of Chandra Shonarthal haor were not accessible to all. During the rainy season, primary education was frequently disrupted during floods almost every year. People used boat to go to schools and health clinics while walking was the only choice when boat did not ply. Schools remained closed for 70 days on average every year due to flooding. The school houses were used as flood shelter for the affected people. On the other hand, students living in distance area usually used to drop their classes due to unsafe communication during monsoon. On the other hand, the flood- induced poverty increased the number of drop-out students in this haor.

Post Project

Health and educational institutions have increased with time and people, especially school going children, have become enthusiastic to go to schools run under different Govt. and NGOs programs. Besides, when the submergible embankments were constructed, local people, school going children, pedestrian, women and other people have been using it as road especially in the dry season. Presently, when some of the locations of the embankments are damaged, people’s way to reach to the schools and health institutions are reported to be hampered for a certain period. But in wet season, deferent types of boats are the main sources of transportation for going to school and health center.

Impact

Impact of the construction of Chandra Shonarthal haor on literacy and health has been marginal: except for inundation of the embankment for, say 2 months a year, the submergible embankments have been used as road to access schools and clinics for the remaining period round the year. Patients on emergency can be taken to clinics by using local vans or rickshaws along the embankment in dry season when alternative roads are not existing. The indirect benefit to education and health services is the increased affordability of small and medium farm households to avail those services with their increased agricultural and ancillary income due to protected crops and other resources from damage as an effect of flood control and drainage infrastructures.

8.6 Land Price

Pre Project

Before intervention, the land price of this Haor region was minimal and people were not interested to buy land due to regular flash flood and crop damage. It is reported by local people that the price of agricultural land was 5000 to 7,000 Tk per Keyar[1] and Tk.12, 000 to Tk.14, 000 for homestead land before project.

[1] 1 Keyar = 30 decimals

Post Project

With the project-induced change and autonomous development in the whole Haor region this situation has changed and the land price has increased with the period of time. After the project intervention, the land price has increased due to the increased productivity of land and improved communication system. Though exogenous factors like macroeconomic development and inflation have contributed to raise the land price, people’s interest to buy those land is acknowledged to be one of the reasons of rise in land price.

Impact

Flash flood protection and enabling environment for HYV rice culture have caused the value of land appreciated by more than thrice the pre-project price. Presently, the price of agricultural land per Keyar (30 decimals) is around BDT 70-80 thousand whereas the price of homestead lands learnt as BDT 1.5 lakh to BDT 2.0 lakh per Keyar.

8.7 Agriculture Production based Income

Pre Project

Livelihood opportunities for households in the Chandra Shonarthal Haor region were limited and highly seasonal, as they were focused predominantly on agricultural labour associated with the single annual rice cropping cycle. Fishing was traditionally an important occupation for the people of Haor region. The incidences of livestock husbandry as a livelihood activity in the Haor region were also prominent as their tertiary source of income before the intervention.

Post Project

After project intervention, the income opportunity based on agriculture increased and people got chance to grow more paddy and recruit local labor, generating extra income opportunities for the wage earning households. The scheme area becomes protected from early flash flood due to implementation of the interventions. Additional 7,644 ton of crops are being produced in the scheme area due to interventions implementation and higher yield rate of HYV varieties and newly cultivation of Hybrid Boro, HYV Aman and Jute crops. This benefit might be more practical up to 2012, because functional condition of interventions has been degraded after 2012.

Following table 8.2 shows the agricultural income, based on cropped area and crop production. Based on current production rate (per Ha), agricultural income has been calculated and presented in this table. According to this table, it is observed that, though at present the overall cropped area has decreased but the net production has increased. To calculate the direct financial outcome, the present government rate (tk 21400/ton) of paddy and Jute (tk 71020) has taken under consideration. Before the project intervention farmers got only tk 334.65 million from their paddy. But after the project intervention overall crop production has increased and farmers got tk 227.96 million.

Table 8.2: Agricultural income based on Crop Production

Crop name	Without project Production (tons)	With project Production (tons)	Price BDT(Million)	Increased Income BDT (Million)	Net Increased Income
Lt. Aman	-	663	21400	14.18	
HYV Boro	-	20,936	21400	448.03	
Hybrid Boro	-	1,208	21400	25.85	186.95
Local Boro	15,634	-	21400	334.56	
Jute	-	471	71020	33.45	

Source: Field data, 2017 through FGD, KII, and Informal Interview

Impact

Due to the project intervention additional 7644 ton of paddy are being produced in the study area. Protection from early flood ensured higher yield rate of HYV and Hybrid paddy (Boro). Therefore, the income opportunity of agriculture based households has increased. The total agricultural production based income has been increased about BDT 186.95 million at after project condition.

8.8 Income from Agricultural Wage Labor

Pre Project

Before the project intervention, only the local varieties of paddy were cultivated in the study area. On that time there was no technological innovation or modern input/implement used for crop production. It was found that net demand for labor per ha was near about 120 person for the crop cultivation and a total number of 6.15 lac man days were needed. The following table shows the crop wise labor demand and their gross income. For calculating the labours' income the present local wage rate (BDT 300/day) is considered.

Crop name	Pre-Project Area(ha)	Post-Project Area(ha)	Labor/Ha		Total Man days		Income (Million-BDT)	Net Increased Income (in million Tk)
			Pre-Project	Post-Project	Pre-Project	Post-Project		
HYV Aman	-	214	0	155		33170	9.951	
HYV Boro	-	5,082	0	175		889350	266.805	
Hybrid Boro	-	214		160		34240	10.272	109.017
Local Boro	5,132	-	120		615840		184.752	
Jute	-	214		105		22470	6.741	
Total	5132	5724	120	595	615840	979230		

Post Project

With the changed crop variety and intensity, the labour requirement has increased, but due to improved agricultural practices (transplanting, use of fertilizers and pesticides, harvesting and threshing) the engagement of manual labor has not increase much. From the field investigation and CEGIS estimation it is observed that total number of 9.79 lac man days on an average is needed annually.

Impact

The working opportunities for agricultural labor were limited before project condition as agricultural activities were conducted mainly manually. After project intervention, people gets enabling environment to grow more paddy by introducing HYV crop varieties with intensive land-use. Therefore, additional 3.64 lac labor man days has required now which comes mostly from the local labor community. The direct impact on agricultural wage based income for the laborers has increased BDT 109.017 million.

8.9 Transport and Communication

Pre Project

Before intervention, people mostly used boat during the rainy season, and specific transportations system was not available during that period. People used to go to their desired places on foot in the dry season. The roads for using any kinds of vehicle were not available. Most of the social occasions were held during rainy season only to avail opportunities of using boats.

Post Project

After the period of project intervention, people started to use those submergible embankment as road to go to school, highways, bazaar and health center etc. Though those embankments were not suitable for driving automobiles, people got opportunity to ply with auto rickshaws and bikes during the dry season. But in wet season, boat is the main sources of transport and communication in this region.

During last 5 to 10 years, the damage of submergible embankments have left the school going students, pedestrians, children and women with problems to use those embankment even as *foot path* during the early monsoon period.

Impact

The communication system has become improved as this haor is very close to the Upazila HQ. The BWDB's submersible and compartmental embankments are playing major roles in communication though this is damaged after each flood. Now a days, due to eroding of the submergible road, sufferings of the people have become beggar's description. In the wet season, the sufferings increase many times. Poor communication hampers the overall socio-economic activities and suppresses the developments as well. Proper and protected road networks as well as the water way communication are essential to ensure the overall socio-economic development of the haor people.

8.10 Institution and Governance

Bangladesh Water Development Board (BWDB) was responsible for physical implementation of water sector projects in haor region. Of late, Department of Haor and Wetland Development has been created. As apex institutions, these two have been administering all plans and projects in haor region.

Pre Project

Before the project intervention, local government organization like Union Parishad or Thana Parishad existed with mandate to look after haor water resources. Regular inundation by flood waters was almost a regular phenomenon in haor area. Leasing of Jalmahals was the prime activity of those institutions for raising revenue of the government. It was only after BEDB was created that the issues of water development came in.

Post Project

After the project implementation, Water Development Board started to develop, manage and monitor the project activities in Chandra Shonarthal Haor. Their role for operation and maintenance was regular with the completion of submergible embankments. Presently, it has been found from the consultation with primary stakeholders that those institution are visible only during the period of damage and to monitor the physical condition of those embankments after the flooding condition. According to the local people, the officials from this institution do not consult with the local people for lessening the damaged area of those submergible embankments.

Impact

The presence of BWDB and the Water Management Group has some institutional impact on the beneficiaries of the haor project. Overseeing the operation and maintenance of the infrastructures is the main function of those institutions. But the condition of physical infrastructures of the haor is reported to be running below the desired level.

8.11 Labor and Seasonal Migration

Pre Project

Before intervention, people did not get more access to do other works than the agriculture. People from different regions came to join as work force for crop harvesting and fishing labors. The intensity to come during that period was significant and people's demand specific labors within the haor area were not adequate to assist their agricultural production. The technological innovation for agricultural production was not significant at that period and all activities related to agricultural production were physical labor basis. It was found that net demand for labor per ha was roughly 120 and 60% of the labor came from outside than the locality.

Post Project

After the project intervention, as the agricultural production has increased, livelihood opportunity for wage labour has increased too. The net demand for agricultural labor (having with technological innovation) is roughly 148 per ha. So, a net increase of 28 labour per ha. has enhanced opportunity for their livelihoods. Again, about 20% labours migrate from other regions.

In a cropping season when the working opportunities are available, wage labourers rarely migrate outside of their habitat and instead in-migration takes place during that time. During last ten years people have been facing regular damage due to flood and water logging, in this way, people those who were dependent on agriculture for livelihood were forced to migrate to neighboring districts for better livelihood. During the flash flood, people of this Chandra shonarthal Haor try to find other opportunity to render labour as motor driver, garment workers, rickshaw puller in Sylhet and Dhaka city areas.

Impact

As a result of increased income from wage, relatively poor labour households of Chandra Shonarthal Haor have been able to raise their living standard to some extent. Opportunities of wage income from beyond this haor for those households also have increased due to similar developments in agriculture. Therefore, the net impact of the project on income and living standard of labour households of the Haor is positive.

8.12 Local Social Dynamics

Pre Project

There is conflict of interest in the area mainly between farmers and fishermen group. Before intervention, the conflict of interest was not noticeable but with the project intervention the conflict has emerged.

Post Project

According to the local people, in some areas the local fisherman community cut the embankment in the early monsoon to capture more fish within short time. This cause a huge damage in the agricultural production comparatively at the lower part of the haor. In contrast, the farmers want to keep the embankment from any damage. This is the biggest conflict at this moment of the area in between the farmers and the fishermen community.

Impact

Sometimes social unrest assumes severe proportions due to contrasting grips over the control of water management power.

9. Summary of Impacts

Table 9.1: Summary of Impacts (Key impacts, try to quantification)

Indicators	Pre project	Post project	Impact
Water Resources			
Flooding	▪ The haor was inundated frequently by flash flood during 3rd week of April.	▪ After implementation of submersible embankment and other structures by BWDB in 1993, entrance of flash flood into the haor got delayed by 2 (two) weeks.	▪ Interventions of the haor have reduced the risk of entrance of flood water and saved the crops from damage.
Drainage	▪ Most of the flood water could smoothly be drained out through the Konai, Baulai and Baulai River. The haor bed where agricultural activities were carried out started recession of water during 1st week of December.	▪ Drainage of flood water has been impeded due to interventions. Most of the haor area is drained by the second week of December.	▪ The drainage of the haor has deteriorated in the downstream side as the Dubail regulator is not working properly in the post moonsoon period.
Sedimentation	▪ The sediment carried by the flash flood got deposited both in the rivers and haor area. Hence, sedimentation was not that much problem before implementation of the interventions.	▪ Sedimentation has taken place in the rivers over the years. As a result the bed level of the rivers has risen and conveyance capacity has also been reduced.	▪ Sedimentation has increased compared to the pre-project condition.
Navigation	▪ During pre-project period, there was navigational connectivity between the haor and the peripheral rivers throughout the year.	▪ Navigational connectivity between the haor and peripheral rivers like Kangsha, Konai and Baulai mainly remains operative during monsoon. Besides, navigation also operates through the breached points and public cuts before repairing in February/March. Moreover, boats can	▪ The navigational connectivity has not been affected in monsoon but it does not operate during pre-monsoon.

Indicators	Pre project	Post project	Impact
		ply freely within the haor for fishing and other purposes. However, navigational connectivity does not persist during pre-monsoon due to repairing of submersible embankment.	
Land Resources			
Land use(ha)	▪ Gross area: 6,334 ▪ NCA:5,346 ▪ Others:988	▪ Gross area:6,334 ▪ NCA:5,349 ▪ Others:985	i)NCA:+3 ii)Others:-3
Land degradation	No	Change	Change
Agriculture Resources			
Cropping intensity (%)	96	107	+11
Cropped area (ha)	▪ Rice: 5,132 (Boro: 5,132) ▪ Non Rice: 0	▪ Rice: 5,724 (Boro: 5,296,Aman:214) ▪ Non Rice: 214	▪ Rice:+378 ▪ Non Rice: +214
Crop production (ton)	▪ Rice: 15,634 (Boro: 15,634) ▪ Non Rice: 0	▪ Rice: 23,278 (Boro: 23,278) ▪ Non Rice: 471	▪ Rice:+7,644 (Boro: +6,510,HYV Aman;+663) ▪ Non Rice: +471
Crop damage (ton)	▪ Rice: 2,958 ▪ Non Rice: 0	▪ Rice: 6,623 ▪ Non Rice: 0	▪ Rice:+3,665 ▪ Non Rice: 0
Irrigated area (ha)	▪ Rice: 5,132 ▪ Non Rice: 0	▪ Rice: 5,296 ▪ Non Rice: 0	▪ Rice:+164 ▪ Non Rice: 0
Surface water Irrigation availability	▪ Available	▪ Deficit during month of February to March	▪ Deficit
Agro-chemicals use (ton or kiloliter)	▪ Fertilizers: 0 ▪ Pesticides: 0	▪ Fertilizers: 1,757 ▪ Pesticides: 45	▪ Fertilizers:+ 1,757 ▪ Pesticides: +45
Livestock Resources			
Livestock population (number)	▪ Cattle:3,150 ▪ Goat:570 ▪ Duck:6,540 ▪ Chicken:8,570	▪ Cattle:6,580 ▪ Goat:720 ▪ Duck:9,630 ▪ Chicken:13,970	▪ Cattle:+3,430 ▪ Goat:+150 ▪ Duck:+3,090 ▪ Chicken:+5,400
Fisheries Resources			
Fish habitat area	• Total fish habitat area- 5,669 ha • Habitat area breakdown: ○ River and Khal- 30 ha ○ Beel- 195 ha ○ Floodplain- 5,346 ha ○ Baor-97 ha	• Total fish habitat area- 5,670 ha, • Habitat area breakdown: ○ River and Khal- 25 ha ○ Beel- 192 ha ○ Floodplain- 5,349 ha ○ Baor- 85 ha ○ Extensive Fish Pond- 20 ha	• Gain of total fish habitat area only by about 1 ha.

Indicators	Pre project	Post project	Impact
Fish habitat Condition	• Habitat quality and suitability condition was in favor of fisheries; • Maintained unregulated ecosystem with better provisioning (i.e., fish) and supporting (i.e., fish nursery and breeding grounds) services like sustainable fisheries.	• Habitat quality and suitability condition becomes little degraded; • Increased pollution load due to intensified Boro cultivation.	• Slightly degraded habitat condition driving towards relatively less sustainable mentioned provisioning and supporting services majorly fisheries.
Fish Diversity	• Open water loving fish species were distributed over the area more or less evenly.	• Abundance of some biologically and commercially important fish species become low or rare locally; • Population of bentho-pelagic like *Puntius ticto*, *Notopterus chitala*, *Labeo calbasu*, etc. and demersal fish species like *Clarius batrchus*, *Channa punctatus, Macrognathus aculeatus*, *Lepidocephalichthys guntea*, etc. affected more due to dewatering of Beels and indiscriminate fishing in Beel leasing system; • Open water loving fish species were distributed over the area more or less evenly; • Increased abundance of culture fish species. • *Wallago attu* has predominantly been increased.	• Little imbalance in fish species distribution over the area; • Possible inbreeding problem due to increase of culture exotic fish species.
Fish migration	• Unregulated lateral fish migration from river to floodplain and floodplain to river through Khal.	• Since the scheme is not fully functional so fish migration status has no significant	• There is little implication of interventions on fish migration.

Indicators	Pre project	Post project	Impact
		deviation from the Pre Intervention condition. • Pre-monsoon and post-monsoon (August-October) lateral migration was hindered by regulator in Alipur and Chandpur Village	
Fish production [2]	• Fish production in 1989 was about 542 metric ton.	• Fish production in 2015 was about 2,113 metric ton.	• Overall fish production gain is about 1,571 metric ton in 2015 compared to production of 1989.
Fishing Appliances	• Sustainable fishing was done using suitable mesh sized fishing gears. • Use of Kona Jal /Mosquito net (small mesh sized net) was not reported. • Fishing pressure at the mouth of the Khals during recession period was very low except leased Beel connecting Khals (only by LH).	• Unsustainable fishing is being done using small mesh sized fishing gears like Kona Jal /Mosquito net (mesh size below 1 cm); • Fishing pressure at the water structure points during recession period is more because of engagement mass people.	• Increased use of unconventional fishing appliances and thus increased fishing pressure.
Fishers Livelihood	• Commercial fishers were about 2% meaning some livelihood fully dependent on fishing. • No part-time and subsistence fishing people.	• Part-time fishers (20%) become dominant in floodplain fish habitat meaning carrying livelihood with fishing is not adequate and need other income generating activities. • Fishing people are more.	• Fishing based livelihood becomes unsustainable.
Fisheries Management	• Beel fishery maintained three-year rotation in harvesting fish; • Fish got more time for propagation;	• Beel fishery is being maintained mostly one-year rotation in harvesting fish.	• Beel fishery is being secured by the scheme though the weak enforcement is not yielding expected benefit.

[2] Major contribution to the increased production came from adoption of fisheries management like Beel fishery, increasing fishing activities, fishing commercialization, stocking of culture fish species in Beel fishery, etc.

Indicators	Pre project	Post project	Impact
	• Sustainable fishery.	• Fish is not getting enough time for propagation; • Unsustainable fishery.	
Ecosystem			
Terrestrial flora	Settlement land area was about 114.17 ha area. Different homestead vegetations covered majority of the terrestrial floral composition of the overall haor. Indicator tree species were commonly found.	Settlement vegetation has been increased to 143.48ha area. Plant diversity also increased over time as local people introduced fast growing species and fruit yielding plant in and around their settlement area.Indicator tree species moderately found.	Pitali, Hijal, Koroch and Nolkhagra have been decreased due to agricultural and human settlement expansion.
Terrestrial fauna	Diversified terrestrial wildlife (amphibian, reptilian, aves and mammals) species were commonly found.	Different anthropogenic activities are reducing the diversity and population of terrestrial fauna. Some small mammals and bird species became extremely rare.	Interventions have no direct relation with the change of faunal condition in Chandra Sunarthal Haor project.
Aquatic flora	Numerous beels and khals provide rich aquatic vegetation. Shapla, Makhna, Singra were available in shallow land at the south-eastern part of the Haor. Indicator species were common.	The perennial water body of the Chandra Sunarthal Haor area decreased about 3.06ha over time. Siltation rate is also increasing. Anthropogenic activities poses threat for some species like Shapla,Makhna, Singra etc.	Loss of habitat for some aquatic floral species. No direct impact for intervention activities.
Aquatic fauna	A large number of migratory birds were found at Dubail, Rajapur and Dosvagiya village. Turtle and Checkered keelback were available in study area.	A few numbers of migratory birds is seen in winter. Over extraction, Hunting Killing, Trapping, Fishing method causes reduction of frog, fish population, turtle, and waterfowl over the study area.	Habitat loss causes relocation and reduction in the population of aquatic fauna.
Swamp Forest and Reed land	Swamp forests were occupied at Rajapur and Mahadipur in Chandra Sunarthal Haor area. But a huge land area was covered as reed beds and fallow land almost 485.47ha. Swamp forest and reed land	Only a small portion of swamp forest is remaining in the study area. Vegetable practice on reeds bed and fallow land has been introduced overtime. Swamp forest and reed land condition is in vulnerable condition.	Conversion of reed bed into crop production land causes damage of wildlife habitat. Intervention may facilitate converting reeds bed into agricultural land.

Indicators	Pre project	Post project	Impact
	condition was in optimum level.		
Ecosystem goods and services	The overall ecosystem goods and services in Chandra Sunarthal haor was in optimum level.	Irrigation facilities provide extra facilities for more production. Different method of fishing practice is followed over the study area. Over extraction of edible plants had happened due to population demand. Converting grazing land into seasonal crop production is a big issue. The overall ecosystem goods and service status has been changed.	Provisional services has boosted up and regulating and cultural services has reduced
Socio-economic Conditions			
Employment Opportunity	Total cropped area was 5132 ha whereas about 120 man days labour (per hector) inputs were needed.	Total cropped area were 5724 ha where about 149 man days labor input were needed	✓ Additional 3.63 lac labor man days has been employed due to the change in the crop variety which was possible for intervention. ✓ Employment opportunity has been created during the period of operation and maintenance of those projects in Chandra Shonarthal Haor
Agriculture and wage base income	✓ The total agricultural production value at current price was BDT 334.56 million ✓ The agricultural wage base average income was about BDT 184.75 million.	✓ The total agricultural production value at current price is BDT 521.52 million ✓ The agricultural wage base average income is about BDT293.76 million	✓ Agricultural production base income was increased due the project intervention up to BDT 334.56 million ✓ Agricultural wage labor income increased up to 109.01 during the period of after project condition.
Labor and Seasonal Migration	✓ The demand for labor per ha near about 120 and maximum labor came from outside than the locality.	✓ The demand for agricultural labor is near about 148 per ha.	✓ The net demand for labor has been 28 labour-days per ha. Local wage earning households within the project have more livelihood

Indicators	Pre project	Post project	Impact
			opportunity and their socioeconomic situation has slightly improved with more wage income.
Land Price	✓ The price of agricultural land was 5000 to 7000 Tk per *Keyar and that of homestead land was between BDT 12,000 to 14,000 only*	✓ The price of agricultural land is near to be 70-80 thousand per Keyar whereas the price of 1.5 lakh to 2.0 lakh for homestead lands.	✓ Asset value of land has appreciated for all land owning households, making them more credit worthy for more assets to own.
Accessibility in Health and Educational institution	It was tough to go to schools and health institutions especially in the wet season.	✓ People started to use the embankments as their way of communication. ✓ With the damage of certain locations of the embankments people felt in-secured to use their way of moving during the rainy season. ✓ School going children sometimes fall in problem in using breached embankments as their way to go to schools.	The communication system rendered people comfortable at least during dry season but frequent breaches have left them uncertain about using embankment as road as long as these are not submerged.
Institution and Governance	✓ Local Union Parishad used to manage local water resources and Beels and Haors were managed by Deputy Commissioner at district level.	✓ The institutions (i.e. WDB) constructed embankments and has been conducting O&M of infrastructures ✓ Local people's participation in planning and management has been insufficient land hence governance ineffective.	✓ Institutional presence (of BWDB) is seen but efficiency of flood control system is at the low ebb. ✓ In absence of participatory management body within Haor, the governance position does not turn out meaningful.

10. Environmental Management Plan

Table 10.1: Management Plan

Impact	Mitigation Measures	Enhancement Measures
Flooding	• The submersible embankment should be repaired as per design section within the month of February every year. • Causeway should be constructed at suitable locations to avoid major damage of embankment by public cuts. • Awareness raising program should be carried out against public cut. • The beels, khals and rivers should be dredged/ re-excavated to increase carrying capacity and thereby reducing the impact of flood. • The dredging work should be done in a proper way so that the leeves of the Kangsha and Konai River do not get eroded.	
Drainage and Sedimentation	• The rivers and khals should be dredged/ re-excavated on a need basis. • Sufficient outlets should be constructed at suitable locations for easy drainage. • Katakhali Sluice gate should be repaired for the betterment of local stakeholders	
Navigation	• The outlets should have boat pass facility to maintain navigational connectivity.	
Land use change		• Agricultural land graving should be avoided. • Fallow land should be brought under cultivation
Increased cropped area		• Kanda should be utilized for vegetables cultivation. • Hydroponics or floating bed vegetables cultivation should be introduced. • Medium high and medium low land should be utilized for short duration and submergence tolerant T Aman (BINA dhan7, BINA

Impact	Mitigation Measures	Enhancement Measures
		dhan 11, BINA dhan12 and BINA dhan 13) cultivation. • Flood tolerant submergence variety (BRRI dhan51, BRRI dhan52 and BRRI dhan79 may be tested.
Increased crop production		• Crop area should be increased by utilization of fallow land. • Short duration high yielding and hybrid varieties should be developed/introduced/strengthened. • Crop damage should be minimized by timely and proper rehabilitation of water control structures like embankment, regulators, drainage sluices etc.
Increased irrigated area and Availability of irrigation water	• Regular re-excavation/dredging of the Kangsho and Konai has to be ensured in order for retention of irrigation water.	• Re-excavation of existing beels and khals should be ensured for retention of irrigation water. • Re-excavation of connecting Saitankhali khal, Dubail khal and Ranokhali khal etc. • Irrigation water should be ensured by stopping draining out of the beels during early dry season for fish harvesting.
Status of livestock/poultry		• Grazing area should be increased by utilizing fallow land. • Awareness build up through training • Marketing facilities should be improved. • Availability of high yielding breed should be ensured.
Increased crop damage	• Close the breach/public cut properly. • Raise this section of the submersible embankment height up to 5 to 6 feet in respective locations.	

Impact	Mitigation Measures	Enhancement Measures
	• Completion of the rehabilitation work by December-January. • Regular dredging of the rivers has to be ensured in order to reduce the intensity of flash flood. • About 3-4km new embankment should be constructed from Ullashkhali-Daulotpur area. • Maintenance work of the embankments. • Chandpur, Alipur and Dubail regulators should be removed due to have design problem. • Constriction of four new regulators: a) 3-vent regulator at the location of Ullaskhali; b) 1-vent regulator at the location of Airadair; c) 2-vent regulator at the location of Saitankhali; and d) 1-vent regulator at the location of Kaingar bandh. • Rehabilitation works should be finished by February • Quality materials should be used for rehabilitation works. • Short duration high yielding or hybrid varieties should be used instead of long duration BRRI dhan29 variety. • Local varieties should be transplanted in the deeper part of the haor area instead of short height high yielding or hybrid variety.	
Increased use of agro-chemicals	• Farmers should be encouraged to use organic manure to increase soil fertility while avoiding water contamination and reduce the soil fertility. • Farmers should be encouraged to cultivate leguminous crops to enhance the soil quality. • Farmer should be follow modern agricultural technology like Integrated Pest Management/Integrated Crop Management(IPM/ ICM), Good Agricultural Practices(GAP) etc.	
Increased fish habitat area	• Not applicable	• Maintenance work should be conducted as and when necessary for keeping water at a level in the Khal

Impact	Mitigation Measures	Enhancement Measures
		suitable for fishery but not detrimental to agriculture crops; • Coordination among the line agencies should be increased and involve agencies in their respective functions. In this case should involve Upazila Fisheries Office.
Slightly degraded fish habitat quality and condition	• Water holding capacity in the Khals and in all Beels should be increased through re-excavation/ dredging; • Maintain minimum 1 m water depth in almost all water bodies during dry season.	• Not applicable
Imbalance in fish species distribution and vulnerability to demersal and bentho-pelagic fish species	• Unconventional fishing appliances (i.e., fine meshed gears, dewatering, poisoning, etc.) should be banned; • Should motivate and encourage agriculture sector people for abstaining from use of chemical fertilizers and pesticides for keeping water uncontaminated.	• Beel nursery programme with native fish species should be increased; • Build more sanctuary with the involvement of adjacent fishers community; For sanctuary Dharam Beel and Chadra Beel are suitable; • The protected area should be guarded especially at night by the professional fishers of adjacent village for facilitating fish species diversity and fish propagation.
Insignificant alteration to fish migration	• Increase the conveyance capacity of Khal maintaining minimum 1 m depth during dry season; • Should bring fish friendliness in the existing structures and new structures should be fish friendly. Structures should be Khal's width-wide, roughness of the structure wall & bottom, water retention at minimum 1m depth in the dry season, etc. • Fishing should be controlled during pre-monsoon and recession period.	• Proper maintenance work should be conducted and monitored by the Project Implementation Committee (PIC). • Monitoring and awareness building activities should be conducted through fishers' communities under the guidance of Upazila Fisheries Officer.
Increased fish production	• Beel fishery should be promoted with three-year rotation; • Beel dewatering should be stopped.	• Above measures.
Increased use of unconventional fishing	• Unconventional fishing appliances should be stopped;	• Not applicable

Impact	Mitigation Measures	Enhancement Measures
appliances and thus increased fishing pressure.	• Should increase law enforcement for controlling unlawful fishing. • Strong surveillance for maintaining water control structures through controlling fishing.	
Fishing based livelihood becomes prominent.	• Not applicable	• Fishing ban time income generating activities should be promoted. In that case, the fisher's community should be involved in water management group.
Beel fishery is being secured by the scheme though the weak enforcement is not yielding expected benefit.	• The scheme should be maintained with the coordination of the line agencies.	• Not applicable.
Hijal, Koroch and Nolkhagra have been decreased due to agricultural and human settlement expansion	• Keeping the kandas and village grooves untouched in Govt. khash land. • Initiating plantation programme along the river levees, kandas and other khash lands	
Reduced population of Pallas's Fish Eagle, Vulture and Monocellate Cobra	• Increase people awareness about wildlife conservation • Govt. initiative is required to conserve respective amount of natural vegetation and reedland in the haor area	
Reduced Water Lilly, Makhna, and *Chhaila* Grass	• overharvesting of aquatic plant resources should be controlled by the responsible authority	
Turtle and Eurasian Otter has been disappeared; Reduced population of migratory birds and other resident aquatic bird species	• Identify the core habitat for the endangered animals and take action to conserve the respective habitats • Aware local farmers for using optimum doses of fertilizers and insecticides	
Reduced biodiversity regarding the swamp forest and their vicinity Nolkhagra have been rare due to conversion of reedland	• All the khash land with swamp forest and reedlands should be out of public lease and allotments	• Awareness campaign should take place among the masses regarding the issue
(Livelihood and employment opportunity)	**-**	• Training would be ensured for the creation of

Impact	Mitigation Measures	Enhancement Measures
• New employment opportunity had been created with the increase of agricultural production • Employment opportunity has been created during the period of operation and maintenance of those projects in Chandra Shonarthal Haor.		alternative livelihood options • Submergible embankment must be repaired using the local labor • Allocation of all beel /Jall Mohal to the actual fishermen on equity basis • Soft loan would be provided especially in the emergency period (i.e. post flooding condition) • Build up linkage with farmer and national, international traders.
(Agriculture and wage based income) • Agricultural production based income increased due the project intervention. • Agricultural wage labor income increased with project.	-	• New variety of crops and its profitable production should be ensured among farmers. Appropriate training programs should be initiated for farmers to cope up with the changing climate and technology
(Labor and Seasonal Migration) • The demand for skilled and unskilled labor increased during project construction.	-	• Skill development training program should be initiated for capacity building especially for men and women to enable them to continue with the skill as livelihood opportunity in similar construction works.
(Land Price) • The opportunities for agricultural production increased for which the value of agricultural lands is also increasing	--	• Regular Operation and Maintenance (O&M) and riverbank protection work should be continued properly to keep the land optimally productive.
(Accessibility to Health and Educational institution) • The submergible embankments provided opportunity to be used as road with project intervention.	-	• A functional monitoring Committee should be formed in association with WDB and local people to identify damaged parts of the embankment • Local participation has to be ensured to repair minor damages to embankment.

Impact	Mitigation Measures	Enhancement Measures
• Due to lack of proper maintenance, the damage of the embankments was increased and local people started to face problem to use these embankments as their means of communication.		
• (Institution and Governance) • There is no mechanism to consider local people's ideas and concerns while drawing project operation and maintenance systems. Project people suffer crop loss and other household vulnerabilities. • The role of institution to consider public demand in policy, operation and maintenance on the issue of those submergible embankments.	• Quarterly Meeting should be initiated with local water and flood protection committee to understand the gap of institutional policy and governance • A functional Monitoring team should be formed to visit submergible embankments • People's feedback should be taken before the implementation of any kind of policy in relation to new project and maintenance and operation of those submergible embankments.	-
(Livelihood and employment opportunity) • New employment opportunity had been created with the increase of agricultural production • Employment opportunity has been created during the period of operation and maintenance of those projects in Chandra Shonarthal Haor.	-	• Training would be ensured for the creation of alternative livelihood options • Submergible embankment must be repaired using the local labor • Allocation of all beel /Jall Mohal to the actual fishermen on equity basis • Soft loan would be provided especially in the emergency period (i.e. post flooding condition) • Build up linkage with farmer and national, international traders.

Appendix A

Table A1: Availability of major fish species in Chandra Sunarthal Haor

Sl. No.	Local Name	Scientific Name	IUCN Status, 2015
1	Ayre	*Sperata aor*	VU
2	Bacha	*Eutropiichthys vacha*	LC
3	Baghair	*Bagarius bagarius*	CR
4	Baila	*Glossogobius giurus*	LC
5	Bajari Tengra	*Mystus tengara*	LC
7	Barobaim	*Mastacembalus armatus*	EN
10	Boal	*Wallago attu*	VU
11	Catla	*Catla catla*	LC
14	Chapila	*Gudusia chapra*	VU
15	Chang	*Chana orientalis*	LC
18	Chital	*Chittala chittala*	EN
19	Darkina	*Esomus dandicus*	LC
26	Ghoinya	*Labeo gonius*	NT
29	Gojar	*Channa marulius*	EN
33	Gutum	*Lepidocephalichthys guntea*	LC
34	Kabashi tengra	*Mystus cabasius*	NT
35	Kachki	*Corica soborna*	LC
36	Kaikla	*Xenentodon cancila*	LC
37	Kajuli	*Ailia coila*	LC
38	Kalibaus	*Labeo calbasu*	LC
40	Kanipabda	*Ompok bimaculus*	EN
42	Kashkhaira	*Chela laubuca*	LC
43	Katari Chela	*Salmostoma bacaila*	LC
44	Kholisa	*Colisa fasciatus*	-
47	Koi	*Anabas testudineus*	LC
48	Kuchia	*Monopterus cuchia*	VU
50	LalChanda	*Chanda ranga*	-
51	Lal kholisa	*Colisa lalius*	-
52	Magur	*Clarias batrachus*	LC
53	Mrigal	*Cirrhinus mrigala*	NT
55	Mola	*Amblyphayngodon mola*	LC
58	Nandil, Nandi, Nandina	*Labeo nandina*	CR

Sl. No.	Local Name	Scientific Name	IUCN Status, 2015
59	Napit koi	*Badisbadis*	NT
64	Potka	*Tetradon cutcutia*	LC
68	Rani	*Botia dario*	EN
70	Rita	*Rita rita*	EN
71	Rui	*Labeo rohita*	LC
72	Shilong	*Silonia silondia*	LC
73	Shing	*Heteropneus fossilies*	LC
74	Shol	*Channa striatus*	LC
77	Tara baim	*Macrognathus aculatus*	NT
78	Tengra	*Mystus vittatus*	LC
80	Tit puti	*Puntius ticto*	LC
81	Veda/ Mani	*Nandus nandus*	NT

Apendix B: Photo Album

Water Resources

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Chaptir Haor System

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1. Introduction

1.1 General Information

The Chaptir Haor System is located in between 24°44' and 24°51' latitude and between 91°26' and 91°21' longitude. It is located in Derai Upazila of Sunamganj District. The project has a gross area of 4622 ha of which 3450 ha has been benefitted from the project. This Haor system is bounded by Dhankunia and Joydhona Haor in the northeast, Haizda embankment on the southwest and the Pagnar Haor in the eastern side. Joysree, Dakshin Sukair Rajapur and Dharmapasha unions are under this haor system. The Land slopes down from west to east side of the project area. The project area is connected with Kalni River directly, with other small rivers and canals surrounding the area. Many beels and water bodies lie within the project, which are the only source of cultivation water is available in the dry season.

1.2 Project Descriptions

The Chaptir Haor System in Derai upzila of Sunamgonj district is a Flood Control and Drainage (FCD) project. The project was initiated by Bangladesh Water Development Board in 1995 and was completed in 1998. A total of 44 km embankment has been constructed around the project. 14.5 km drainage channel has also been excavated. Inside the project area 3 regulators in Dhtipur, Chanpur and Taral; 7 sluices in Taila, Singhanath, Atparia, Matargaon, Dakshin Nagergaon, Kalardhar and Taral and 1 inlet in Singhanath have been constructed. The project was initiated in 1995 and completed in 1998.

- 44 km embankment,
- 3 numbers of regulators
- 7 numbers of sluice gates
- 14.5 km drainage canal numbers of pipe sluices

1.3 Present Status of the Project Interventions

Most of the interventions in the preoject area has become very old. Often they fail to operate properly. The embankment of the Chaptir Haor has deteorated in many plces. This causes untimely entry of flood water. The gates of most of the sluices are hard to drop and water becomes hard to control.

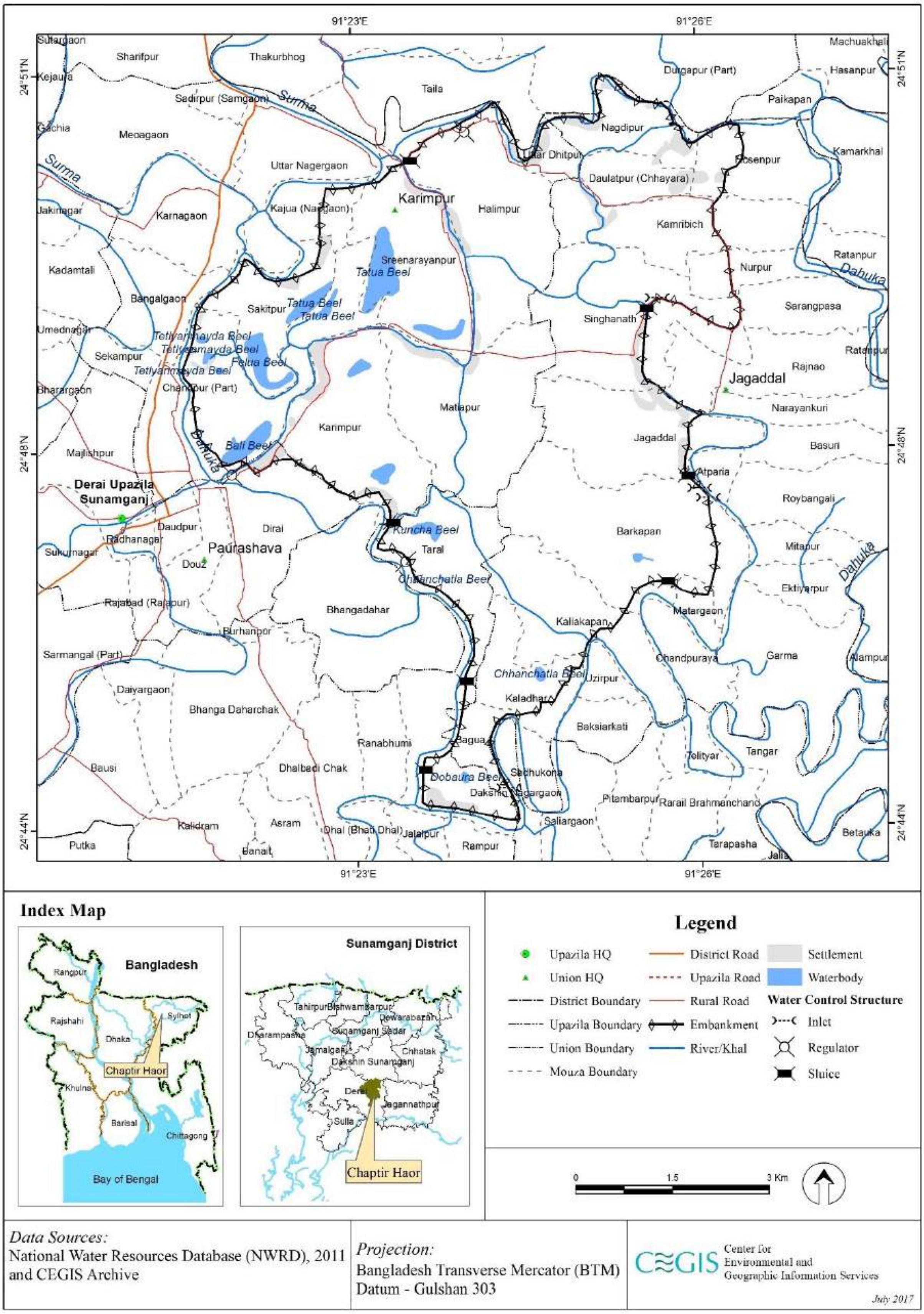


Figure 1.1: Hydrological Features of Chaptir Haor

2. Water Resources

2.1 Flooding Situation

Pre Project

Before the construction of the embankment, flooding used to take place all across the haor area. The water generally comes from the north-west side, Kalni River through different canals. Due to different ground levels in the haor, the flooding depth varies. The maximum depth is found to be 16’-18’ and the minimum depth 7’-8’. During the monsoon flood, most of the villages including Matiapur, Sakitpur, Halimpur, Tajpur, Chandpur, Ditpur faced submergence.

Post Project

After the construction of the embankment, the situation has changed in most of the areas. Flooding situation has both improved and worsened across the haor area. For example, the north-west side of Karimpur Mouza does not get flooded, while the east side remains flooded after the construction of the embankment and a sluice. It is said to be the impact of the intervention. The situation of the monsoon has improved on the other hand. The villages that faced submergence during the monsoon before the infrastructure, now do not face flood in the monsoon.

Usually, the flash flood water enters in the month of May (Bengali: mid Baishakh). But for the last 2-3 years, the timing of water entry has advanced and floods the haor in March (Bengali: mid Chaitra). This change in the flooding pattern has increased the damage to both the crops and the embankment. The gates of sluice and regulators are generally opened on 15 May, but the early water is causing damage to embankment. Due to climate change, the pattern of monsoon has changed and the flash flood takes place much earlier than it used to be.

Impact

The impact of the intervention can be described as both positive and negative. During the flash flood, the intervention has helped few places to get rid of flood and again it is blamed to be the cause of flood in few places where there shouldn’t be flood. But the most important change that it brought is the improvement of flooding in the monsoon. Villages have not faced any severe flood after the construction of the embankment.

2.2 Drainage Condition

Pre Project

The drainage condition in Chaptir Haor System used to be up to the mark before the projects were taken. Flood water did not have any problem in draining down from inside the haor area. The canals responsible for the drainage of the flood water were fully functional before the construction of the embankment. This made the water drainage process regular.

Post Project

Directly or indirectly, the drainage condition is accounted to be worse than the pre-project status. Chamti Khal is one of the main sources for the drainage in Chaptir Haor. The bed of the channel has been filled up with sedimentation and makes the water stay longer in the Haor system. During the monsoon, due to excess rain, many village face internal flooding which was not a problem in the pre-interventional time. This water faces difficulty to drain down. There is no complain of water logging in the dry season inside the Chaptir Haor System.

Impact

Water cannot drain out from the haor system easily after the interventions. The drainage mouth of the Chaptir haor is getting filled up by sediment after the construction of embankment and this is why water stays for a longer time in the haor. As a result, the farmers have wait more days to start the agricultural works. The longer durability of flood water in the villages has also made the livelihood of the villagers more miserable.

2.3 Sedimentation and Siltation

Pre Project

Before the construction of the embankment and other structures, there was no problem regarding sedimentation. The biggest problem that sedimentation has caused in the Chaptir Haor system is the filling of the channels which were to carry the flood water away from the haor. There is a possibility that, the river and channel beds around the Chaptir Haor were not filled with sediment and silt that much. With the passage of time, the beds started filling up gradually and no impact of sedimentation was seen until the interventions were initiated.

Post Project

Sedimentation problem has increased a lot after the construction of the embankment in this haor area. The foot of the sluices and the regulators are getting filled up with sedimentation due to lack of maintenance work. The regulator near the Chanpur in Derai, has lost functionality due to sediment and lack of maintenance. This regulator connects the Chaptir Haor with Chamti Khal. Chamti Khal has also lost its true conveyance capacity due to sedimentation. The depth of this khal has become 15 feet, where it used to be 35-40 feet once. Sediment has caused the same problem to all the canals and river adjacent to the Haor. After the drainage of the water, there is said to be layer of sedimentation of 6 to 8 inches on the agriculture land. This additional soil is hard and time-consuming to remove from the vast amount of the land. Some beels like Dobaura Beel, Chhanchatla Beel, parts of Tetlyanmayda Beel are also said to be filled up with sediment and silt and not to have existence or the the depth of water they used to have before the construction of the interventions.

Impact

Sedimentation has changed a lot of scenarios in Chaptir Haor System after the intervention. Deceasing the conveyance capacity of the canals and river is the main impact of the sedimentation in the Haor System, which has caused the elongated the period of the flood water. Again, the extra sediment on the agricultural land has increased the pre work before starting any agricultural work.

2.4 Wave Action and Erosion

Pre Project

Erosion due to wave action was severe before the embankment was constructed. Many villages naming Karimpur, Halimpur, Kaliakapan faced erosion due to erosion, locally called

'Aafal'. At the beginning of the dry season, when the water starts to drain, the erosion was severe.

Post Project

With the intervention on field, the erosion due to wave action is accounted to be less. Only few local roads constructed by the local governments inside the haor is seen to be the victim of the erosion due to wave action. Other villages do not face erosion severly.

Impact

The impact of wave action is lessened after the intervention. Previously, most of the villages faced erosion, but after the implementation of the project the erosion did not cause much problem across Chaptir Haor. Only some vulnerable structures inside the haor has faced erosion.

2.5 Navigation

Pre Project

Navigation before the intervention did not face much problem in Chaptir Haor. The haor is directly connected with Kalni River. This river is the main path of transportation all the way to Meghna River. Inside the haor, only motorized trawlers and non-motorized man driven boats ply on. These boats have drafting levels from 5-15 feet of water. In the pre interventional condition few numbers of boats navigated in the haor. This number did not surpass 30. There was no problem with navigability either. Number of ghats were also few. Long before the interventions, about 50-60 years earlier, launches used to navigate in the haor in the monsoon. Due to lack of passengers and financial crisis, the launches stopped operating.

Post Project

The after interventional condition in the Haor has changed a lot of things in navigation sector. The irregular existence of water in some parts of the haor, naming Karimpur Mouza after the construction of the embankment has created a problem for the villagers to move by boats. On the other hand, the timely regulation of water has made the movement easy and predictable for them. They use boats 8-9 months of the year and motorbikes in the 4 months of the dry season for their movement.

Impact

The impact of the intervention in Chaptir haor has generated problems and convenience simultaneously. The variable height of water caused by the embankment is a problem for the people in the haor to move on. Then the proper regulation of water has made the mode of transportation system convenient.

3. Land Resources

3.1 Land Resources

The project area has fallen in one Agro-ecological zone, namely: Sylhet Basin (AEZ-21). Acid basin clays and Non-calcareous grey floodplain soils (non-saline) are the dominant soil. The top soil texture are clay and clay loam; where clay texture is dominant. The soils are slow permeable and have a medium moisture holding capacity. The land type characteristics are not uniform within the project area. About 73% of cultivable areas are low to very low land where minimum flooding depth is above 1.8 meter during the monsoon period. The recession of surface water from most of the agriculture land starts at middle of December and become free of flood water in late January.

Two indicators (Land use and Sand carpeting area) have been selected for assessing the impact on land resources due to structural interventions in Haor ecosystem. The land use and sand carpeting information under pre-project and existing situations were identified through analysis of the available archived satellite images of CEGIS and it was verified through Focus Group Discussion (FGD) and Key Informant Interview (KII).

3.2 Land Use

Pre Project

The project boundary has been considered as similar to post project. The gross area of the project was 5,065 ha, of which Net Cultivated Area (NCA) was 4,408 hectare. The rest area was covered with water bodies (perennials beels/haor, river and khals) forest and rural settlements including homestead vegetation. Details are presented in Table 3.1.

Post Project

Total gross area remaining same and the Net Cultivated Area (NCA) is 4,452 hectare. The rest area is covered with water bodies (perennials beels/haor, ponds, river and khals), forest and rural settlements including homestead vegetation. Details are presented in Table 3.1.

Impact

Net Cultivated Area, forest and rural settlements including homestead vegetation has increased about 44, 8 and 3 hectare while water bodies' area have decreased 54 hectare respectively. Detailed impacted area is presented in Table 3.1.

Table 3.1: Detailed Land Use in Chaptir Haor System

Land use	Pre-project area(ha)	Post-project area(ha)	Impact(Post-project-Pre-project)
Net Cultivated Area(NCA)	4,408	4,452	+44
Water bodies	181	127	-54
Forest	182	190	+8
Rural Settlement	293	296	+3
Total	**5,065**	**5,065**	**0**

Sources: Satellite Image-Landsat OLI, 1989 and 2015

3.3 Land Degradation

No sand carpeting was found in before and after implementation of the project.

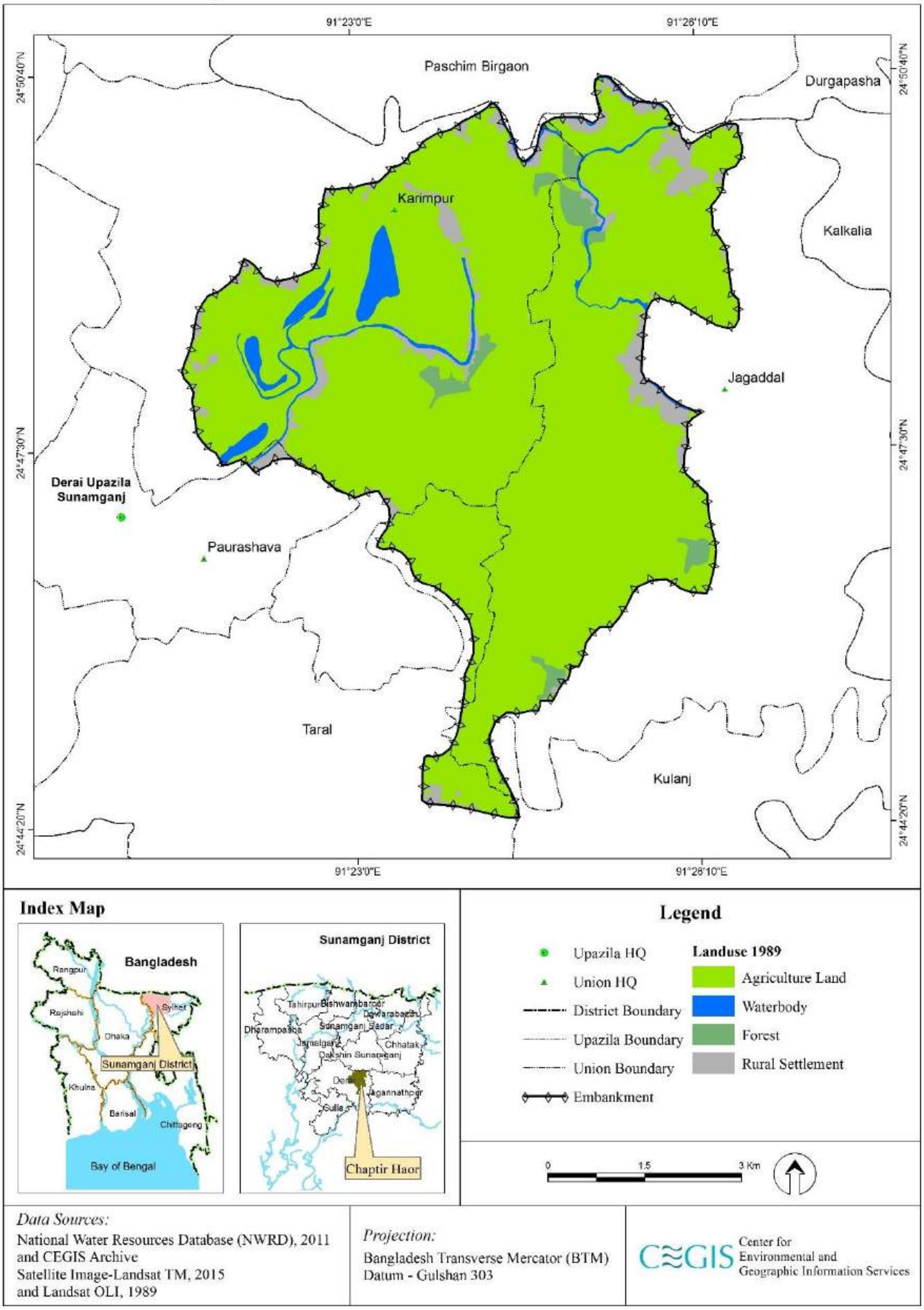


Figure 3.1: Land Use of Chaptir Haor System (1989)

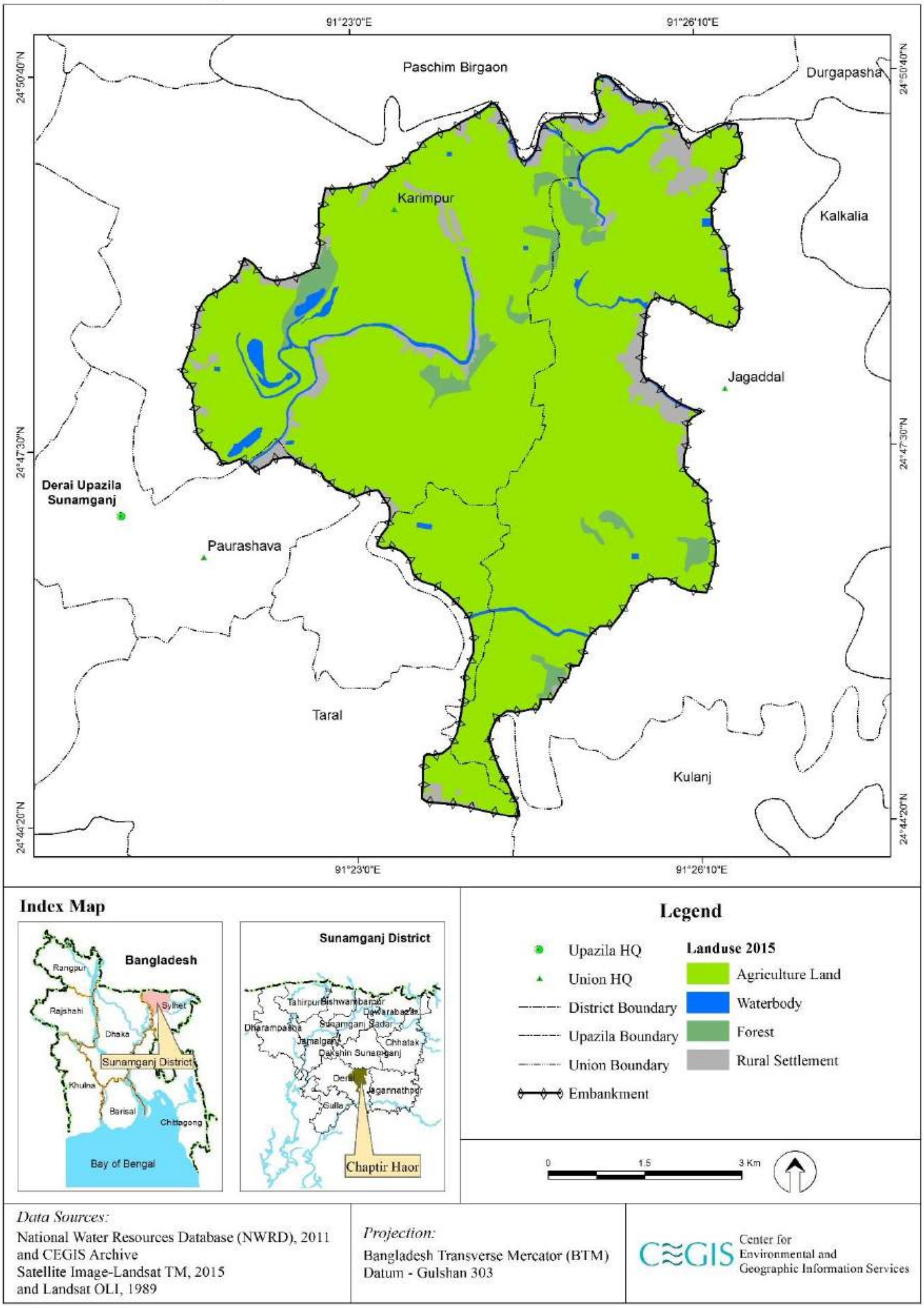


Figure 3.2: Land Use of Chaptir Haor System (2015)

4. Agriculture Resources

Boro rice is the main crop in Haor areas. In most cases, pre-matured or matured Boro crops are damaged by early flash flood which generally happened due to pre-monsoon heavy rainfall in the hilly areas. Besides, drainage congestion and irrigation water scarcity due to siltation of rivers, Khals and Beels are the another problem for Haor agriculture.

Six indicators (cropping intensity, crop area, crop production, crop damage, irrigation and use of agro-chemicals) have been selected for assessing the impact on agriculture resources due to structural interventions in Haor ecosystem. The information of these indicators were collected from both primary and secondary sources. The primary data were gathered from stakeholders through Focus Group Discussion (FGD) and Key Informant Interview (KII). The secondary data were collected from Bangladesh Bureau of Statistics (BBS) and field level Department of Agricultural Extension (DAE) office.

4.1 Cropped Area, Cropping Pattern and Intensity

Pre Project

Before the project interventions, the Net Cropped Area (NCA) was 5,408 hectare, where only one cropping pattern Fallow- Fallow- Local Boro was found. The land type of this project area was very low land (about 72% of NCA) followed by very low and medium low land and low land as presented in Table 4.1.

Farmers usually grew Local Boro crops in Rabi season. Different varieties of Boro rice such as Gochi, Boro, Tepi Boro, Jagli Boro and Shail were very much popular among the farmers. The total cultivated area was covered with single cropped area. So, the cropping intensity of this area was 100%. Detailed cropping pattern by land type under pre-project situation is presented in Table 4.1.

Table 4.1: Pre Project Cropping Pattern of Chaptir Haor System

Land type	Kharif-I (March-June)	Kharif-II (July-October)	Rabi (November-February)	Area (ha)	% of NCA
Medium Low Land(F_2)	Fallow	Fallow	Local Boro	1,190	27
Low Land(F3)	Fallow	Fallow	Local Boro	44	1
Very Low Land(F4)	Fallow	Fallow	Local Boro	3,174	72
			Total	**4,408**	**100**
			Cropping intensity (%)	**100**	

Sources: CEGIS estimation based on field information and image analysis, July; 2017

Post Project

The project area became protected from early flash flood due to the interventions, which influence farmers to grow HYV Boro and Hybrid Boro crops instead of Local Boro. The most popular varieties which are used in the project area are BRRI dhan 28, BRRI dhan 29, Janak raj, Aftab, Chandra, Hira and Jholok. The Net Cultivable Area (NCA) has been increased to 4,452 hectare after interventions. Dominant cropping pattern of the project area is Fallow -

Fallow - HYV Boro covering 73% of the NCA. The total cultivable area is covered with single cropped area. So, the cropping intensity remained same, which is 100%. Detailed cropping pattern by land type under with project situation is presented in Table 4.2.

Table 4.2: Post Project Cropping Pattern of Chaptir Haor System

Land type	Kharif-I (March-June)	Kharif-II (July-October)	Rabi (November-February)	Area (ha)	% of NCA
Medium Low Land (F_2)	Fallow	Fallow	Hybrid Boro	1,202	27
Low Land (F3)	Fallow	Fallow	HYV Boro	45	1
Very Low Land (F4)	Fallow	Fallow	HYV Boro	3,205	72
			Total	4,452	100
			Cropping intensity (%)	100	

Sources: CEGIS estimation based on field information and image analysis, July; 2017

Impact

The Net Cultivated Area (NCA) has been increased 1% (44 hectare) after the interventions. On the other hand, total cropped area remain same as NCA. The cultivated area of Local Boro has gradually been decreased and replaced by Hybrid Boro/HYV Boro variety after completion of project due to its higher yield rate and ensured early flash flood protection by project interventions. Impact on cropped area is presented in Table 4.3.

Table 4.3: Impact on Cropped Area in Chaptir Haor System

Crop Name	Pre Project Area (ha)	Post Project Area (ha)	Impact (Post Project-Pre Project)
Hybrid Boro	**-**	1,202	+1,202
HYV Boro	-	3,250	+3,250
Local Boro	4,408	-	-4,408
Total	**4,408**	**4,452**	**+44**

Source: CEGIS estimation based on field information, July; 2017

4.2 Crop Production

Pre Project

The estimated total annual crop production of the project area was about 13,936 tons after loss of 2,032 tons before any interventions. Detailed crop production statistics before interventions is presented in Table 4.4.

Table 4.4: Annual Crop Production in Chaptir Haor System under Pre Project Situation

Crop name	Total Crop Area(ha)	Damage free area		Damaged area		Annual Production (ton)	Production Lost (ton)
		Area (ha)	Yield (ton/ha)	Area (ha)	Yield (ton/ha)		
Local Boro	4,408	3,526	3.6	882	1.3	13,936	2,032
Total	**4,408**	**3,526**	**-**	**882**	**-**	**13,936**	**2,032**

Source: CEGIS estimation based on field information, July; 2017

Post Project

After the implementation of the project, hydrological regime of the project area is changed. Farmers started to cultivate Hybrid/HYV Boro due to presence of submersible embankment and sluicegate, which protect their crops from early flash flood. Hence, total annual crop production is about 19,816 tons with loss of 2,551 tons after interventions. Detailed estimation of crop production after interventions is presented in Table 4.5.

Table 4.5: Annual Crop Production in Chaptir Haor System under Post Project Situation

Crop Name	Total Crop Area(ha)	Damage free area		Damaged area		Annual Production (ton)	Production Lost (ton)
		Area (ha)	Yield (ton/ha)	Area (ha)	Yield (ton/ha)		
Hybrid Boro	1,202	962	6.6	2,40	3.3	7,126	792
HYV Boro	3,250	2,112	4.4	1,137	2.9	12,691	1,759
Total	**4,452**	**3,074**	**-**	**1,378**	**-**	**19,816**	**2,551**

Source: CEGIS estimation based on field information, July; 2017

Impact

Additional 5,880 tons rice is being produced in post project situation. The rice production is increased due to the protection of flash flood which encourages the farmers for practicing high yielding variety instead of local variety. Detailed estimation of impact on crop production is presented in Table 4.6.

Table 4.6: Impact on Crop Production in Chaptir Haor System

Crop name	Pre Project Production (ton)	Post Project Production (ton)	Impact (Post Project-Pre Project)
Hybrid Boro	-	7,126	+7,126
HYV Boro	-	12,691	+12,691
Local Boro	13,936	-	-13,936
Total	**13,936**	**19,816**	**+5,880**

Source: CEGIS estimation based on field information, July; 2017

4.3 Crop Damage

Pre Project

Flash flood was the main cause of crop damage in pre-project situation. Before harvesting of Boro crop, water entered into the Haor area and damaged the crops. So, farmer of this area suffered due to the damaging of their crops in every year. Total crop damage in the project area was 2,032 tons annually. Detailed estimation of crop damage is presented in Table 4.4.

Post Project

Chaptir Haor is now protected from early flash flood by the project interventions which basically performed well up to 2014. After that, most of the year, flood water enters into the project area before harvesting of Boro crop (early to mid-March) due to low height of submersible embankment and malfunctioning of structures.

The main source of flooding is Mara Surma-Kalni River. The excessive upstream flood water coming through Surma -Mara Surma – Kalni hits the submersible embankment located at the south- west of the haor project in the middle of April. The submersible embankment built over the canals at south-west part of the project (i.e. Baishakhir Khara, Chatol, Patni Hatir Khara, and Chanpurer Bara Khal) along the river Kalni are breached first, then other weaker parts including the low height part of the same embankment got breached and flooded the haor. Simultaneously, the flash flood water of Mahashing-Dauki River and Kamarkhali River from northeast and east side respectively overtopped the submersible embankment and entered into the haor. In this haor, the submersible embankment at Baishakir Khara (a deeply scoured canal) got breached in most of the year and as a part of the project at the south end submerged quickly. In this section, a compartmental dyke has been built from east (Chatol) to west (Koliarkapon) to block the flash flood water into the main haor area. But most of the year, this compartmental dyke failed to protect the floodwater, as it is not strong enough and high as required. Every year BWDB closes the major breaches and entrances of the khal. The main reason for flooding in this Haor over the years is that the rivers have silted up and their water flowing capacities are gradually reducing. The excessive sedimentation makes rivers incapable of holding and conveying floodwater, which creates excessive pressure on earthen embankment. Moreover, plant height of hybrid/HYV is less than local varieties and growing period of most of the Hybrid/HYV varieties are higher than local varieties except BRRI dhan28. So, flood water affects the whole crop area at a time. The devastating floods of 2004 inundated the haor. Local people reported, around 90% of Boro crop both local and HYV were damaged during the devastated flood. In 2007, 95% Boro crops were damaged. But, this year (2017) 100% crop is damaged in pre-mature stage during early March. Most vulnerable Mouzas such as Sakitpur, Karimpur, Matiapur, Halimpur, Tajpur, Chandpur, Ditpur and Tek derai are identified in this respect. Total crop damage is recorded as 2,550 ton after interventions. Detailed estimation of crop damage after interventions is presented in Table 4.5.

Impact

Though, the crop damage area has been increased from 20% to 35% after interventions. However, the amount of crop damage has increased by 518 tons because the total production has increased significantly. The crop damage area is increasing day by day due to malfunctioning of the interventions and reduced water carrying as well as retention capacity of surrounding rivers, khals and beels. Detailed impact assessment on crop damage is presented in Table 4.7.

Table 4.7: Impact on Crop Damage in Chaptir Haor System

Crop name	Pre Project Production Loss (ton)	Post Project Production Loss (ton)	Impact (Post Project-Pre Project)
Hybrid Boro	-	792	+792
HYV Boro	-	1,759	+1,759
Local Boro	2,032	-	+2032
Total	**2,032**	**2,550**	**+518**

Source: CEGIS estimation based on field information, July; 2017

4.4 Irrigation

Pre Project

Before initiation of the project, only surface water was used for irrigating Local Boro crops. The local people normally transplanted this crop immediately after the floodwater recedes and the land is under shallow inundation. Local farmer reported that they stored water with help of bundh/dyke management and irrigated their crop with the help of flooded water in the low lying part of the Haor. They also used traditional modes like *Seuti, Don and Cone* for irrigating their crop from surrounding rivers, Beels and Khals during dry season. Prior to the implementation of the project, irrigation water was more available than the requirement of crops.

Post Project

After implementation of the project, the irrigation water demand has been increased due to cultivation of high water demanding Hybrid/HYV Boro instead of Local Boro crop. On the other hand, the availability of surface water is being reduced due to siltation of surrounding rivers, khals and beels of the project area. Therefore, the scarcity of irrigation water has been observed from early February to end of March in most of the year. In this time, Chamti river, and Kalni river), khals (Chamti khal,Dalar khal,Dulni khal) and beels(Hatni beel, Tatua beel, Felua beel, Tetlyan Mayda beel, Kuncha, Bali beel, Sandua, Dobaura beel, Kakchira beel) are the main source of surface water irrigation. Mainly Low Lift Pumps (LLPs) is being used for lifting surface water instead of traditional mode. The Chamti river and Khals (Chamti khal, Dalar khal, Dulni khal) dried up during dry season(January-February). Kuncha beel are bailing out in January-February for harvesting fish.

Impact

There was deficit of irrigation water due to increase of water demand and decrease of water availability during dry season. The irrigation water demand has increased for cultivating high yielding crop variety. On the other hand, surface water irrigation availability has decreased due to siltation of rivers, khals and beels of the project area.

4.5 Agro-Chemical Use

Pre Project

Farmers of the project area cultivated only Local Boro in pre-project situation. They didn't apply agro-chemicals for crop cultivation. However, some farmers used inorganic fertilizer like mixed grass and rice straw in the crop field for the restoration of soil fertility.

Post Project

Generally more agro-chemicals are required for cultivating HYV /Hybrid Boro crops. So, farmers applied more agro-chemicals for Hybrid/HYV Boro crop cultivation. Total about 942 tons chemical fertilizers, 1.197 Kilo litre liquid and 19 tons granular/powder pesticides were used in the project area for crop cultivation per year. Detailed use of agro-chemicals under post-project situation is presented in Table 4.8.

Table 4.8: Use of Agro-chemicals in Chaptir Haor System under Post-project Situation

Crop Name	Fertilizer (Kg/ha)			Total (kg/ ha)	Pesticides		Total	
	Urea	TSP	MP		Liq (ml/ha)	Gran. (Kg/ha)	Liquid (Litre/ ha)	Granular/ Powder (kg/ha)
Hybrid Boro	180	50	70	300	400	6.0	0.4	6.0
HYV Boro	125	40	40	215	300	5.0	0.3	5.0

Source: CEGIS estimation based on field information, July; 2017

Impact

Use of agro-chemical has increased largely under post-project situation compared to pre-project situation. Additional about 942 tons chemical fertilizers, 1.197 Kilo litre liquid and 19 tons granular/powder pesticides are used for crop cultivation annually. Detailed impact on use of agro-chemical is presented in Table 4.9.

Table 4.9: Impact on Agro-chemicals in Chaptir Haor System

Crop Name	Pre-project			Post-project			Impact		
	Total Fertilizer (ton)	Pesticides		Total Fertilizer (ton)	Pesticides		Total fertilizer (kg)	Pesticides	
		Liquid (Kilo Litre)	Powder (ton)		Liquid (Kilo Litre)	Powder (ton)		Liquid (Kilo Litre)	Powder (ton)
Hybrid Boro	0	0	0	321	0.395	6	321	0.395	6
HYV Boro	0	0	0	621	0.802	13	621	0.802	13
Total	**0**	**0**	**0**	**942**	**1.197**	**19**	**942**	**1.197**	**19**

Source: CEGIS estimation based on field information, July; 2017

5. Livestock Resources

Livestock and poultry, being an essential element of integrated farming system, play an important role in the economy of the Haor area. Livestock provides significant draft power for cultivation, threshing and crushing of oil seeds; cow dung as a source of manure and fuel; a ready source of funds; and meat, milk and eggs for human consumption. A large number of livestock are reared in Haor areas but constrained by flash flood causing inundation of large areas during most of the time in the year. This area is famous for duck rearing due to availability of natural feed for ducks in natural large water bodies. All of livestock species suffer much due to shortage of feed, outbreak of waterborne diseases and inadequate shelter facilities. The livestock rearer in the Haor areas do not get fair price due to poor communication as well as lack of marketing facilities.

The indicator status of livestock has been selected for assessing the impact of the project. The status of livestock population data were collected from Livestock Census (1986), Agriculture census (1996 and 2008) of BBS. The status of livestock feed and fodder, diseases, marketing facilities information were gathered from stakeholders through Focus Group Discussion (FGD) and Key Informant Interview (KII).

5.1 Status of Livestock Population, Feed and Diseases

Pre Project

According to livestock census 1996, the livestock and poultry population in the project area were 5,610 cattle, 490 goats, 10,950 chicken and 9,880 ducks (Table 5.1). Before implementation of the project, the major feed available to ruminants was mostly crop residues (rice straw) supplemented with weeds from cultivated fields. They are to depend on naturally grown grasses in Kandas and alongside roads and embankments. Most of the year before implementation of the project, the crops were to damage by early flash flood. As a result, shortage of feed from crop residues, reduction of grazing facilities seriously affect livestock rearing. That time, the small holders were to depend on water hyacinth and other aquatic plant for their cattle. The major poultry feeds were rice bran, broken rice, kitchen wastes like rice, rice-gruel, vegetables, fish wastes etc. In addition, the duck usually scavenge in the nearby water bodies like Haor, beel, khal, river or any other low lying areas; mainly eat various types of aquatic insects, small fish, shell or snails. Major livestock and poultry diseases were Foot and Mouth Disease (FMD), Rheumatoid/Athritis, Gola fula (Hemorrhagic Septicemia), worm infestation and Badla (Black Quarter), Duck cholera, Fowl pox and Fowl cholera etc. in the project area. The most vulnerable period was between July to November for spreading diseases to livestock and poultry populations. Mortality rate of the livestock/poultry was higher due to poor shelter condition and they lived in unhygienic condition. Marketing facilities was not in good condition and price was also low due to less demand of their products and by products. Producer consumed their products at family level and additional products were sold at local village market.

Figure 5.1: Ducks at Sakitpur Mouza in the Study Area

Table 5.1: Status of Livestock/Poultry in Chaptir Hoar System

Livestock/ Poultry Category	Pre Project		Post Project		Impact
	No of Households having Livestock	Total No of Livestock	No of Households having Livestock	Total No of Livestock	Number of Livestock Population
Cattle	1,440	5,610	2,030	7,240	1,630
Goat	210	490	150	380	-110
Chicken	1,870	10,950	2,350	14,270	3,320
Duck	1,510	9,880	1,260	8,000	-1,880

Source: CEGIS estimation based on livestock census (1996), agriculture census (2008) and field information (July 2017)

Post Project

According to agriculture census 2008, the livestock and poultry population in the project area are 7,240 cattle, 380 goats, 14,270 chicken and 8,000 ducks (Table 5.1). After implementation of the project, crop is protected from early flash flood. As a result, the feed availability of livestock is increased due to increase of crop production. However, some of the year, the crops were damaged by early flash flood. In that year, the small holders were dependent on water hyacinth and other aquatic plant for their cattle. The poultry feeds are same as in pre project situation. On the other hand, more or less similar diseases are found in post project situation. The mortality rate of the livestock/poultry became negligible during the project period, due to extension works at farmers' level such as immunization and insemination program by Department of Livestock (DLS). Marketing facilities during dry season also improved due to improvement of the communication system by constructing the submersible embankments. Therefore, market prices are increased due to high demand of products and by products.

Impact

From 1996 to 2008, about 1,630 cattle have increased due to the reduction of flood vulnerability, improvement of marketing facilities and strengthening of livestock extension services. On the other hand, the goat, chicken and duck population has been decreased to 110, 3,320 and 1,880 respectively. Details about impact on livestock are presented in Table 5.1.

6. Fisheries Resources

Chaptir haor system is bounded by four river system (mentioned in water resource section). These act as the major water sources for maintaining sustainability of fish habitat through three such connecting khals as Chamti Khal, Dalar Khal and Dulni Khal which are acting as the major migratory routes between river and haor system. Some beels are perennial in nature (mentioned in water resource section) acting as the major winter refuges and breeding/spawning ground, whereas some are seasonal which are drying up by January-February. It was found that the change of fisheries resources in response to intervention varies with different indicators which are briefly discussed below.

6.1 Fish Habitat Area

Pre Project

Fish habitat has been assessed from the landuse data that is extracted from the satellite image of 1989. The estimated total area of fish habitat of the haor was about 4,538 ha where capture fishery was the sole contributor. There were some extensive fish ponds covering very insignificant portion of the haor. Floodplain shares the major part (about 97%) of habitat in the total area followed by River, Khal and Beels. The breakdown of functionally different fish habitats of this Haor is given in Table 6.1.

Post Project

Similarly, the estimated fish habitat area has been assessed from the land use data, which extracted from image of 2015, is about 4,549 ha. The net gain of habitat area is about 12 ha. This occurs due to shrinkage of beel area by 43 ha. However, the area of rivers, khals and floodplain were increased by 3 and 43 ha respectively. The shrinkage of beel occurs may be due to converting into agricultural land in some extent. The breakdown of functionally different fish habitats of this Haor is given in Table 6.1.

Table 6.1: Analysis of Fish Habitat in the Study Area

Sl. No.	Habitat Category	Habitat Type	Area (Ha)		Impact (Ha)
			Pre Project, 1989	Post Project, 2015	(Habitat Area Change)
1	Capture Fishery	River and Khal	78	81	3
2		Perennial Beels	51	9	-43
3		Floodplain	4,408	4,452	43
4	Culture	Extensive Fish Pond	0	8	8
Grand Total Area =			**4,538**	**4,549**	**12**

Source: CEGIS estimation using field data and land use data prepared using Google Earth Image 1989 and 2015.

Impact

It has been found from google image for two periods (respecting with (2015) and without (1989) intervention) that total habitat area for fisheries was increased by 12 ha.

6.2 Habitat Condition

Pre Project

Evenly distributed of high hydrodynamic fish species (such as, *Ompok bimaculatus, Eutropiichthys murius, Labeo boggut and Botia dario*) as the perception of commercial fishermen indicated that the high hydrodynamic condition was prominent with sufficient discharge, water velocity, water depth before implementing project (particularly sluice gates and different types of culverts). The habitat condition respecting water depth and pre-monsoon water flow was sufficient with which such as *Botia dario, Badis badis, Ompok bimaculatus, Eutropiichthys murius, Labeo boggut, Chela laubuca, Salmostoma bacaila, Colisa faciata* and *Trichogaster lalius*were more adapted. New water coming from associate rivers and khals and rainfall is one of the limiting factors for successful breeding and spawning of both the 'White' and 'Black' fish species. In case of Pre-Project scenario, there were sufficient connectivity which can maintain the entrance of new water with which fish species, particularly 'Black' fishes, were well adapted.

Post Project

The hydrodynamic condition was more or less same in Post-Project scenario with sufficient discharge and water velocity. However, water depth was decreased by 3-4 feet caused due to sedimentation. The availability profiles for indicative fish species indicate that the habitat condition respecting water depth and pre-monsoon water flow was decreased significantly with which such as *Botia dario, Badis badis, Ompok bimaculatus, Eutropiichthys murius, Labeo boggut, Chela laubuca, Salmostoma bacaila, Colisa faciata* and *Trichogaster lalius*arenot adequately adapted. The Beel habitat, used by 'Black' fishes for breeding and spawning, lost suitability in some extent through Beel leasing activities. In case of Bali beel, moreover, the spawning activities are disturbed through hindering new water from Kalni to Bali Beel through Chamti Khal. Week connectivity during pre-monsoon caused due to sedimentation and regulator.

Impact

However, the habitat suitability condition for rivers, khals and beels was being declined due to decreasing water depth. It results in increasing critical water velocity (particularly for SIS of fishes) at critical water depth (based on maximum body height of the fish species) for increasing discharges during pre-monsoon period.

6.3 Fish Diversity

Pre Project

The undisturbed moderate to high hydrodynamic haor system maintains about 90 fish species which were more or less evenly distributed. Moreover, large-sized adult fish species was more frequent. For example, the occurrence of 60kg weighted Boal (*Wallago attu*) was available.

Post Project

At present about 90 fish species are available in the haor area as reported by the local fishers. Even they informed that some of the fish species (*L. nandina, Arius gagora, Bagarius bagarius, Botia dario, Chitala chitala, Clupisoma garua, Labeo nandina*, etc.) which was unavailable few years ago, at present these species are observing in some extent. The availability profiles of observer fishes in the Chaptir haor area indicate that Boal (*Wallago attu*), Tengra (*Mystus vittatus*), Gonia (*Labeo boggut*) Tit Punti (*Puntius ticto*), Chela (*Salmostoma bacaila*), Tara Baim (*Macrognathus aculeatus*), Mola (*Amblypharyngodon mola*), Rui (*Labeo ruhita*), Catla (*Catla catla*), Kalibaus (*Labeo calbasu*) are more abundant fish species Post-Project scenario (**Table-A1 of Appendix-A**).

Impact

It was found from availability profile of eco-morphometric group of different indicative fish species that the availability of swimming functional group was changed in Post-Project scenario as compared to the Pre-Project. The swimming capacity of fish species is directly related to the water velocity and water discharge which are regulated directly by different water control structures in Chaptir Haor.

6.4 Fish Migration

Pre Project

Successful fish migration primary depends on the sufficient connectivity among river-khal-beel and floodplain. In Pre-Project scenario, as local fishermen stated, the natural connectivity of the Chaptir Haor successfully facilitated both the longitudinal (particularly 'White' fishes) and lateral migration (particularly 'Black' fishes). The suitable habitat condition of rivers and khals because of undisturbed water velocity with continuous discharge in time at sufficient water depth facilitated medium to large-sized fishes (like *Wallago attu, Salmostoma bacaila, Ompok bimaculatus, etc*) to migrate from beels to river for breeding. On the other hand, fry fishes were successfully migrated through khals by drifting migration. Because, there were no fishing pressure at the mouth of khals. Furthermore, most of the fries of SIS of fishes become adult and they moved everywhere in the haor system the rivers, khals, beels and even floodplain of which become one water body. When water moves back from beels and floodplain towards river system, these beel adapted SIS of fishes move to their main habitat, beels. This undisturbed scenario, thereby, facilitated an evenly distributed fish community structure of the Chaptir haor.

Post Project

Among the interventions, submergible embankment, sluice gates, regulators and culverts hindered the pre-monsoon lateral migration particularly of brood fishes and drifting migration of fry fishes. It has been stated that during first decades after implementing submergible embankment the availability of fries became low. This may due to hindering pre-monsoon flood water in to the haor system. However, this scenario last for one decades after implanting intervention. Post-Project scenario, lateral migration of moderately hydrodynamic condition, beel, adopted brood fish (e.g. *Wallagoattu, Salmostomabacaila, Ompokbimaculatus, Badisbadis, etc.)* was inhibited by changing water condition at sluice gates, regulators and culverts. It has been found from fish passage model and the perception of local fishermen that the swimming profile (prolonged and burst swimming) of medium to large-sized fishes had been changed for increasing discharge with increasing water depth during pre-monsoon.

Impact

It has been found in case of sluice gate and culverts (Box Culvert and Pipe Culverts), the water depth become one of the major barrier for pre-monsoon lateral migration along the total swimming length at 1.5 feet of minimum water depth. Moreover, insufficient depth becomes a significant barrier for pre-monsoon discharge and water velocity for all types of water control structures. Excessive drop at outlet becomes a significant barrier for small to medium sized fishes to migrate through sluice gate and culverts for increasing water velocity with increasing water discharge in the month of May.

6.5 Fish Production

Pre Project

The estimated total fish production was about 394 metric ton (MT) in 1989 where floodplain shared the most about 90% followed by Beel and Channel/khal (Table 6.2).

Post Project

The estimated total fish production is about 1,597 metric ton (MT) in 2015 where floodplain shared the most about 98% followed by Channel/Khal and extensive fish culture. In the production assessment, the productivity of the corresponding year has been used.

Impact

The total fish production was increased by about 305%, whereas the increments of production from floodplain are about 341% (Table 6.2). Such huge increment in productivity may be caused due to adoption of fisheries management like increasing fishing activities, fishing commercialization, stocking of culture fish species in Beel and culture fishery, etc. Moreover, net gain of the conversion of floodplain to borrow pit is by about 1,203 metric ton of fish. The breakdown of fish productions is presented in the following Table 6.2 by functional unit of fish habitats.

Table 6.2: Breakdown of Fish Production by Functional Habitat

Sl. No	Habitat Category	Habitat Type	Production (MT)		Impact (MT)
			Pre-Project, 1989	Post-Project, 2015	[Production Change]
1	Capture	River and Khal	18	18	0.74
2		Perennial Beels	23	9	-14
3		Floodplain	353	1,558	1,205
4	Culture	Extensive Fish Pond	0.0	11	11
		Grand Total Area =	**394**	**1,597**	**1,203**

Source: Fish production assessment based on field findings and FRSS data, 1989 & 2015.

6.6 Fishing Appliance

Pre Project

Different types of gears are used to catch fishes. The fishing gears are namely current jal, kona jal / ghurni jal/ber jal, Thela jal, khora jal, borshi, Kironmala (type of trap used to catch guraicha), Gui (type of trap used to catch small fishes), sip etc. are used to catch the fishes. Furthermore, during fishing in beel, which are included in leasing system, there was illegal fishing practice noticed from local fishermen statement. For example, the total beel was used to dry up during fishing in order to catch benthic fish species. However, this type of fishing depends on the leasing rotation system.

Post Project

The gear selection was more or less same between with and Pre-Project. However, another type of fishing pressure was increased day by day around the water control structures. The local fishermen (particularly part-time fishermen) bounded the mouth of water control structure by bundh Jal in order to catch the fish. This fishing pressure becomes more prominent during post-monsoon with decreasing water level.

Impact

The major impact for fishing practice in Chaptir Haor was noticed that the project created opportunities for increasing fishing pressure at the mouth of water control structures during post-monsoon season without creating proper awareness and integrated operation and maintenance.

7. Ecosystem

The Chaptir Haor consists of different ecosystem scenarios. This haor remain fully flooded at least six months in wet season and remain dry rest of the months. During the dry season, most of the haor area (except few deep beels, homesteads, and kandas) converted into agriculture lands and during the wet season this areas became flooded except few kandas and homestead. In terms of two different hydrological patterns the faunal and floral diversity and their appearance is different. The Chaptir Haor has been covered by bio-ecological zones (BEZ) Haor Basin and consists with terrestrial and aquatic ecosystem. Different type of flora and fauna is occurring in both terrestrial and aquatic ecosystem is present. However, seasonal variation is common in terms of wildlife and floral diversity.

The impact due to intervention in this haor has been assessed undertaking both a desktop and field based assessment of the area during July 2017 through interviewing of key informants and local elderly people by using structured questionnaire (Table 7.1). The brief summary of impact assessment on this ecosystem includes indicator species, habitats and mitigation plan which are described below.

7.1 Terrestrial Flora

Pre Project

Previously, the homestead area of this haor was less. Therefore, the coverage and diversity of terrestrial vegetation in homestead was not as much like present situation. However, coverage of terrestrial vegetation (hijal- *Barringtonia acutangula*, jangli golap- *Rosa involucrata*, bet- *Calamus guruba*, karoch- *Pongamia pinnata*, mera- *Trewia nudiflora*, barun- *Crataeva nurvala*) in kanda area was healthy.

Post Project

The area of occupancy of local terrestrial plant species (hijal- *Barringtonia acutangula*, Karoch- *Pongamia pinnata*, mera- *Trewia nudiflora*, barun- *Crataeva nurvala*) surrounding sites of homestead and kanda area has been reduced due to increase of human population and fuel demand. Subsequently, few tree species sucha as (kadam- *Neolamarckia cadamba*, rendee- *Albizia saman*, kala- *Mus paradisiaca*, dhol Kalmi-*Ipomoea fistulosa*) has been increased in homestead. The coverage of terrestrial vegetation is also increased as the number of human settlement was increased.

Impact

Due to fuel demand two species of plants (jangli golap- *Rosa involucrata*, bet- *Calamus guruba*) disappeared from this haor and subsequently other local vegetation (hijal, Karoch, merra, barun, binna chan- *Vetiveria zizanoides*) plant reduced from kanda and other fallow land areas. Now days, Kanda area occupied by dhol kalmi (*Ipomoea fistulosa*) whereas previously this area emerges with native vegetation (Table 7.1).

Table 7.1: Changes of Status of Terrestrial Flora

Indicator species	IUCN Status [1]	Pre Project Status	Post Project Status	Cause of Status Change	Remarks whether or not changes of status caused due to implementation of intervention (Yes/No)
Pitali (*Trewia nudiflora*)	LC	Common	No change	-	No
Hijal (*Barringtonia acutangula*)	LC	Common	Reducing	Fuel and fishery support demand	No
Karach (*Millettia pinnata*)	LC	Common	Reducing	Fuel demand	No
Barun (*Crateva magna*)	LC	Common	Uncommon	Less demand for fuel wood	No
Dhol Kalmi (*Ipomoea fistulosa*)	LC	Rare	Increasing	High growth rate and fuel demand, high stress tolerant capacity	No
Jangli golap (*Rosa clinophylla*)	VU	Common	Locally disappeared	Over extraction, habitat loss	No
Bet (*Calamus longisetus*)	VU	Common	Locally disappeared	Over extraction, habitat loss	No

7.2 Terrestrial Fauna

Pre Project

Previously the habitat and coverage of natural vegetation in fallow and kanda area was good. Therefore, the diversity of common and rare terrestrial fauna was moderate.

Post Project

Currently common terrestrial faunal species found in village bush, jungle, paddy field are Small Indian Mongoose, Indian Flying Fox, Fulvous Fruit Bat, Golden Jackal, Jangle Cat, Common House Rat, and Greater Bandicoot Rat. Pallas's Fish Eagle an indicator bird of the haor ecosystem is reducing day by day due to unavailability of open water fishes and cutting of tall trees. The terrestrial bird species diversity is higher than other wildlife groups. Common bird species found in the study area are spotted owlet, Brown fish owl, Grey-headed fish eagle, Pallas's fish eagle, Brahminy kite, Black Drongo, Spotted Dove, House Crow, Red-vented Bulbul, Pied Myna, and Common Myna etc. The common reptiles found within this haor area are Common Garden Lizard, Common house Gecko, Keeled Grass Skink and Bengal Monitor. Among the snake Spectacled Cobra and Indian Rat Snake are known to occur in terrestrial habitat. The common terrestrial frog species is Common Toad, Cricket Frog, Asian Brown Tree Frog, Indian Tree Frog etc.

[1] IUCN Status Code: LC-Least Concern; EN-Endangered; CR-Critically Endangered; VU- Vulnerable; NE- Not Evaluated; NA- Not Assessed; DD- Data Deficient; NT- Near Threatened

Impact

The terrestrial faunal composition and species diversity have been changed due to agriculture expansion and population growth. The interventions are protecting the agriculture, therefore, the changed in faunal community is a result of indirect impact of interventions. Due to agriculture conversion, population growth, degradation of natural forest beside the kandas and homestead, terrestrial fauna has been decreased over the past decades specially the mammal species. The population of Golden Jackal, Jungle Cat, has been reduced. Few terrestrial mammal species such as Fishing Cat, Large Indian Civet, Small Indian Civet has been disappeared from this haor area (Table 7.2).

Table 7.2: Changes of Status of Terrestrial Fauna

Indicator Species	IUCN Status	Pre Project Status	Post Project Status	Cause of Status Change	Remarks whether or not changes of status caused due to implementation of intervention (Yes/No)
Brahminy Kite (*Haliastur indus*)	LC	Common	No change		No
White-rumped Vulture(*Gyps bengalensis*)	CR	Uncommon	Locally disappeared	Use of dichlofenac for cattle treatment, large tree cutting	No
Monocellate Cobra (*Naja kaouthia*)	NT	Common	Rare	Habitat loss and human behavior	No
Bengal Monitor(*Varanus bengalensis*)	NT	Common	Uncommon	Habitat loss and human behavior	No
Fishing Cat(*Prionailurus viverrinus*)	EN	Common	Locally disappeared	Degradation of swamp bush along the wetland, Killing by human	No
Small Indian Civet(*Viverricula indica*)	NT	Rare	Locally disappeared	Killing by human, habitat loss	No
Golden Jackal(*Canis aureus*)	LC	Very Common	Common	Killing by human, habitat loss	No
Pallas's Fish Eagle (*Haliaeetus leucoryphus*)	EN	Common	Rare	Feeling of large tree, lack of open water fishers	No

7.3 Aquatic Flora (Habitat Condition and Diversity)

Pre Project

The habitat condition of the aquatic flora and diversity was good without the project situation. Among the indicator floral species abundance of makhana, singra and nolkhagra was good at Chaptir Haor.

Post Project

At the species level Neel Shapla (*Nymphaea nouchali*), *Nymphoides cristatum*, *Nymphoides indicum*, *Ludwigia abscendens* and *Hygroryza aristata* are the most common. The submerged vegetation has been reduced from the beels due to leasing system and fishing activities through at Chaptir haor during wet season. The local farmer treated aquatic plants as weed and currently uses herbicide every year to demolish them. Due to use of herbicide in crop field aquatic vegetation and species diversity has been decreased.

Impact

Among the indicator floral species, makhana, singra and nolkhagra have been disappeared from the Chaptir Haor. Due to fishing activities and use of herbicide in crop field the coverage of chailla gash (*Hmarthira protensa*) has been reduced. The local farmer treated aquatic plants as weed and currently uses herbicide every year to demolish it. Due to use of herbicide in crop field, wild plant vegetation and species diversity has been decreased. The submerged vegetation has been reduced from the beels due to leasing system and fishing activities at Chaptir haor during wet season (Table 7.3).

Table 7.3: Changes of Status of Aquatic Flora

Indicator Species	IUCN Status	Pre Project Status	Post Project Status	Cause of Status Change	Remarks whether or not changes of status caused due to implementation of intervention (Yes/No)
Nol Khagra (*Phragmites karka*)	LC	Common	Disappeared	Agriculture conversion	Yes
Kochuripana *(Eichhornia crassipes)*	NE	Common	Increasing	Stagnant situation, drainage congestion, quick growth	NO
Shapla *(Naymphea nouchuli)*	LC	Common	Rare	Over extraction, Fishing in beel	NO
Makhna *(Euryale ferox)*	NE	Common	Disappeared	Over extraction, Beel leasing, over extraction	No
Singara *(Trapa maximowiczii)*	LC	Common	Disappeared	Over extraction ,fishing in beel, over extraction, Beel leasing	No
Chalia gash *(Hemarthria protensa)*	LC	Common	Disappeared	Use of herbicide	No
Panibaj *(Salix tetrasperma)*	LC	Common	Rare	Over extraction	No

7.4 Aquatic Fauna

Pre Project

Before establishment of intervention the population of Ganges River Dolphin and Eurasian Otter was good. Currently, the population of bird species is healthier than other wetland faunal groups. Common wetland fauna is currently common in Chaptir Haor is Indian Pond Heron, Great Egret, Little Cormorant , checkered keelback, Skipper Frog, Indian Bull frog .

Post Project

Due establishment of permanent closure at connected point of Kalni and Kushiyara river at Markuli, the Ganges River Dolphin migration route has been permanently closed. Due to degradation of swamp forest and reedland for agriculture expansion rare wetland dependent mammal species (Eurasian Otter) has been disappeared from this haor arera. Among the aquatic reptiles species, drastic declined of turtle species from this haor area. This decline has been related to the fisheries bycatch, directed hunting. The population of water dependent frog has been reduced due to use of pesticide and insecticide in agriculture field. Other water dependent birds (resident and migratory) like egrets, duck, wader and herons are severely impacted from squeezing of wetland area and number in dry season for agricultural expansion inside beel area. Leasing systems of beels is another factor for that the lease owners tend to over drying the beels aims to catching fishes and not allow the water birds within the lease area.

Impact

Due establishment of permanent closure at connected point of Kalni and Kushiyara river, the Ganges River Dolphin migration route has been permanently closed. Wetland dependent mammal species (Eurasian Otter) has been disappeared from this haor arera (Table 7.4).

Table 7.4: Changes of Status of Aquatic Fauna

Indicator Species	IUCN Status	Pre Project Status	Post Project Status	Cause of Status Change	Remarks whether or not changes of status caused due to implementation of intervention (Yes/No)
Spotted Flap-shelled Turtle (*Lissemys punctata*), Peacock Soft-shelled Turtle (*Nilssonia hurum*)	LC	Rare	Disappeared	Hunting, beel leasing, embankment, destruction of eggs due to land preparation for cultivation	Yes
Eurasian Otter(*Lutra lutra*)	CR	Common	Disappeared	Degradation of swamp forest	No
Northern Pintailed (*Anas acuta*)	LC	Common	Uncommon	Beel leasing, hunting, agriculture expansion , pesticide	No

Indicator Species	IUCN Status	Pre Project Status	Post Project Status	Cause of Status Change	Remarks whether or not changes of status caused due to implementation of intervention (Yes/No)
Ganges River Dolphin (*Platanista gangetica*)	EN	Common	Disappeared	Closed the migration route by establishment of closure at off take of Kalni River.	Yes
Snail/Oyster	-	Very Common	Common	Domestic duck rearing, using for culture fish feed	No

7.5 Swamp Forest and Reedland (Area Coverage)

Pre Project

Previously no unique swamp forest was present in this haor. However, scattered optimum level of swamp forest and reedlands was present with light coverage.

Post Project

The ree land areas of this haor reduced drastically due to agriculture practice. Previously, reed lands were mixed with vegetation such as baro nal (*Arundo donax*), khagra (Phragmites karka), murta (*Schumannianthus dichotmus*), chitki (*Phyllanthus disticha*) etc.

Impact

Disappeared of Redlands

7.6 Ecosystem Services (General)

Pre Project

The scenario of provisioning services- food (fish, rice); fuel wood; biochemical (medicinal plants); genetic resources of flora and fauna of this haor area was higher than current situation. Climatic condition and other regulation services were good because of vast coverage of natural vegetation. Wetland function was good due to absent of different types of physical structures. Culture service function was also fairly good.

Post Project

Due to implementation of interventions like construction of embankment and installation of regulators for crop protection, the population within this haor area has been increased. To meet up their daily natural resources demand, the genetic diversity of the haor area became less and subsequently provisioning services has been changing day by day negatively.

Impact

The ecosystem services are changing negatively day by day in food, medicine, genetic diversity, and population of flora and fauna. Anthropogenic causes leading indirect effect on fish dependant bird and other wildlife resulting food crisis.

8. Socio-economic Conditions

8.1 Introduction

Flash flood is the main disaster here which engulfs the primary production sector (e.g., agriculture) and thus threatens the lives and livelihoods of the inhabitants of the Chaptir Haor area. Excess rainfall in the upstream hilly areas and subsequent runoff, river sedimentation, unplanned road and water management infrastructure, deforestation, landslide, improper drainage, and last but not least the effect of climate variability can be viewed as the main reasons for the devastation caused by flash floods.

8.2 Demographic Condition of the Area in Pre and Post Project Scenario

Pre Project

The study area contains 26 mouzas, 4 unions under 2 upazilas of Sunamganj district. About 12,295 households were in the Chaptir Haor area has total populations of 82,723, of which 42,799 were male and 39,924 were female. The female population was lower than the male population. The average male-female sex ratio was 107 of which there were 107 males per 100 females. The average density of population was 422 persons per sq. km. The demographic data of this area is presented in **Table 8.1**.

Table 8.1: Distribution of Population and Household in the Study Area

Census Year	Household	Population	Sex Ration	Density
1991	12,295	82,723	107	422
2011	17,805	1,00,311	99	523

Source: Bangladesh Population Census 1991 &Housing and Population Census, BBS, 2011

Post Project

At present about17,805 households are living in the Chaptir Haor area have a total population of 1,00,311 of which 49,882 are male (49.7%) and 50,429 (50.3%) are female. The female population is lower than the male population. The average male-female sex ratio is 99 of which there are 99 males per 100 females. The average density of population is 523 persons per sq. km. The average density of the area has also changed. The average density of the population has changed to 523 from 422 persons per sq. km. The demographic data of this area is presented in **Table 8.1**.

8.3 Livelihood Opportunity of the Population

A livelihood is a means of making a living. For this study livelihood study has been assessed based on the occupation of the people. To assess the impact of the interventions in the livelihood of the Haor people the base situation will be drawn and then the changed situation will also be drawn based on their occupational activity.

8.3.1 Livelihood Status

Pre Project

The majority of the population about 76.3 percent were directly or indirectly dependent on agriculture and works either as farmers or farm labourers. It was found that agriculture was the primary source of livelihood for 45.2 percent of the population. Another 31.1 percent are employed as wage labourers on other farms. Mostly, agricultural labour was an important occupation for the poor landless households. It was also the main occupation for many small farmers. There was some other occupations are of minor importance. Notable among these are business (5.2%), non-farm day labour (3.2%), livestock (4.7%), employees (2.8%), others occupations (4.55%) and fishing (2.65%). All of these occupations were also seasonal and the poor farmers were usually performed this activities. The estimated total annual crop production of the scheme area was about 13,936 tons.

In the study it was found that Fishing, trading and working in other non-farm activities on a daily basis were also important source of livelihood for poorer households. Poor people live mostly on wage labour. Labour contracts were followed certain patterns based on the duration of employment. Contracts may be daily, seasonal or yearly. The majority of labourers were engaged on a seasonal basis and work in exchange for commodities, usually rice. Few male labourers went outside the village or even outside the district to work for a season corresponding to a part of full crop cycle. Women’s seasonal work usually occurred during the harvest. Women engaged as day labourers performed various household task within the community.

Post Project

Still now about 80.4 percent of the population are directly or indirectly dependent on agriculture. Working either as farmer or farm labourers. But with the explorations of various livelihood opportunities the ration has been changed. The landless and the small farmers are shifting their occupation on seasonal basis. The annual crop production is present about 19,816 tons. It is found that agriculture is the primary source of livelihood for 27.20 percent of the households. Another 33.70 percent are employed as wage labourers on other farms and rest 19.6 percent of the population are involved in both farming and as wage labour too. There is also a remarkable change in the occupation of the Haor population. A great portion earn their livelihood from business (5.4%) followed by non-agricultural labour (7.45%), service (4.5%), fishery (1.1%) and transport (1.15%).

Impact

In the past the overall livelihood means of the area was farming. It is observed that due to the intervention the net cultivated areas were increased. Additional 5880 tons crops were produced in the study area due to expansion of HYV/Hybrid crop cultivated area as well as benefit of the project interventions. This has a great impact on the income scenario of the farmers. The farming laborers are tuning to fishing due to different difficulties in agriculture. Now a day’s some people are involved in other occupations like fishing, sand and stone labor, coal laboring, transportation and so on. Due to changing of ecological balance and environment the overall livelihood of the area is being changed. Although farming and fishing were the traditional occupations but due to different intervention like flash flood, siltation of the river and canal bed, lack of drainage system and so on the people are compelled to change their occupation. A good number of people have already left their ancestral dwelling place and migrated to other areas of greater Sylhet, Gazipur, Dhaka, Chittagong in search of better fortune. But the fact that once the area allured people of other areas to migrate in for abundant of wealth.

Figure 8.1: Employment in the Study Area

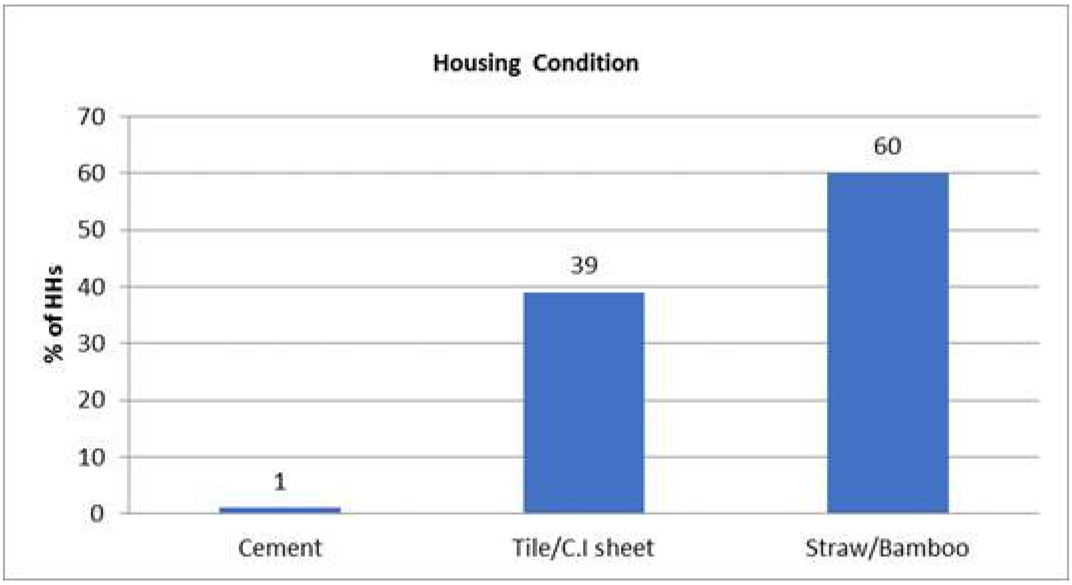
Figure 8.2: Housing Condition in the Haor

8.4 Socio-economic Condition

8.4.1 Housing Condition

Pre Project

The villages are almost cluster and households also. They could not easily expansion the households. Furthermore, with the rapid population growth the population density has also increased and the scenario has also degraded. The study area shows the main house of the dwelling households was predominantly made of straw/Bamboo (60%) over other three types. Tile/C.I sheet and combination of different types of materials household was 39%, Cement was 1%. Most of the straw/bamboo houses are located in Jagaddal union, whereas semi-pucka are predominant at the peripheral areas of Chanpur. Kutcha houses are predominant in the rural area (**Figure 8.2**).

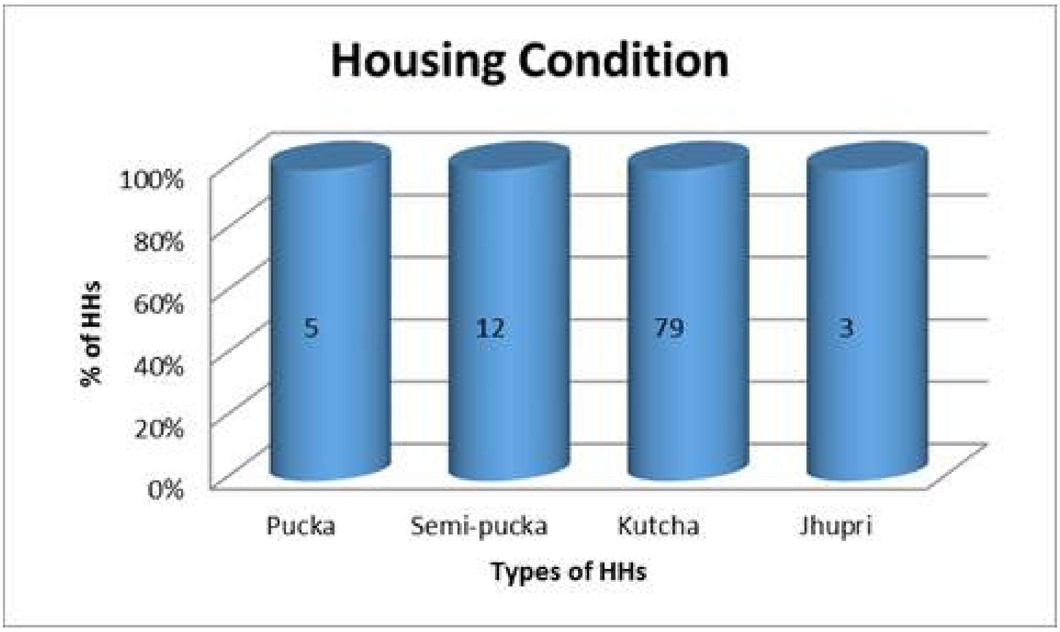


Source: Bangladesh Population Census 1991

Figure 8.3: Graphical Prsentation of Housing Condition in the Study Area

Post Project

According to Bangladesh Bureau of Statistics (BBS) 2011, about 79 percent live in *kutcha* where 12 percent live in *semi pucka*, 5 percent in *pucka* and 3 percent live in *jhupri*. Most of the pucka houses are located in Jagaddal Union, whereas semi-pucka are predominant at the Kulanj union. Kutcha houses are predominant in the paschim Birgaoml area (**Figure 8.4**).



Source: Housing and Population Census, BBS, 2011

Figure 8.4: Housing Condition in the Study Area

Only the large farmer and rich (who live in midlist or others countries) households of the area has tin-shed house with totally metalled floor and tin made roof. Most of the middle class households have tin-shed house with bulrush made fence. On the other hand, most households from the poor have tin-shed and thatched fence in their houses. Some households among them have also paved their house boundary with stones and the remaining have reed and soil macadamized floor perimeter. One third houses of the very poor of the area own tin made roof and thatched fence and the remaining have both thatched roof and fence.

Figure 8.5: Practical Scenario of the Housing Condition in the Haor

Impact

It is found that pre the project intervention, the houses of the village were thatched and straw made (60%). But there had been a change in it in course of time. The Pucka and semi pucka households increase (12% *semi pucka* & 5% *pucka*) Local people argued that post the intervention the rice production has improved and many landless laborer started to sharecrop. Especially, the large farmers were used to give some low lands which were uncultivated pre the intervention to the land less farmers. The Govt. allocated some khas land to the landless farmers. In this way the landless farmers gained some extra income opportunity which helped to improve their housing condition. The people are forced to live in a crowded environment because of scarcity of high land.

8.4.2 Land Ownership

Pre Project

During the field visit it was found that about 8% of the households are absolute landless i.e. which have no lands either homestead or cultivated land, 32% households belong to functional landless category that comprises households those have only homestead lands (cultivated lands include mainly kitchen gardening produced predominantly by housewives mainly for household consumption.), 38% households belong to small farmer, 18% belong to marginal farmer and 4% belong to large farmer categories. Table 8.2 shows the households by land holdings in the study area.

Table 8.2: Households by Land Holdings

Land Ownership Stratum	Households (%)	
	Pre Project	Post Project
Absolute Landless (0 ha)	8	2
Functional landless and marginal farmer (0.004 – 0.198 ha)	32	45
Small farmer (0.202 - 1.008 ha)	38	41
Medium farmer (1.012 – 3.032 ha)	18	10
Large farmer (3.033 ha and above ha)	4	2
Total	**100**	**100**

Source: Field survey/RRA 2017

Post Project

The present scenario of land holding category has changed. The ration of land holding category at present are as follow- absolute landless households 2%, functional landless45%, small farmer41%, marginal farmer10% and 2% belong to large farmer categories. Table 8.2 shows the households by land holdings in the study area. Table 8.2 shows the households by land holdings in the study area. The present scenario of land holding category has changed

Impact

Here, the marginal and small a part of farm owners are passing difficult situation as of regular flood loss and following hazards. They are also losing their own land by distress selling. On the other hand, landless and functional landless farm owners are maintaining their livelihood by doing odd jobs as well as seasonal emigration. A large numbers of landless populations usually adopt alternative livelihood options, for instances; farm and non-farm laboring, driving, earth work, working for shrimp farm and other manual works. It is evidential that land fragmentation decreases the holding size therefore; large and marginal farmers are gradually being converted to small farmers. A section of large farm owners are in good condition and procure the land sold by the marginal, small and a part of functional landless farm owners. The Large farm owners distribute his lands to daughters and sons.

8.4.3 Education

Pre Project

Literacy rate, based on a definition “ability to write a letter in any language” is 25.15%, where for male it accounts to 29.45% and female 20.53%. The rate of literacy reported above is for population of 7 years and over ages. Data confirms that the study area the male populations were more educated than the female counterpart. Most of the girls get married that decreases female attendance. Literacy rate of the studied population is presented in Table 8.3.

Educational facility is moderately good in Chapti Haor for primary level as well as the secondary and higher secondary level as this is near to the Derai Upazila HQ. Nevertheless, primary education is frequently disrupted during floods almost every year. Some partial infrastructural damage often happens. Schools are remaining closed for 70 days in average every year due to flooding as well as the buildings are used as shelter place for the affected people. On the other hand, students living in distance area usually drop their classes due to unsafe communication during monsoon. On the other hand, the flood induced poverty increases the number of drop-out students in this Haor. Nevertheless, proper flood protection may improve children's schooling opportunities and increase the overall literacy as well.

Table 8.3: Literacy Rate in the Study Area

Union	Literacy Rate		
	Both	Male	Female
Jagaddal	24	28.4	19.2
Karimpur	28.7	32.2	24.9
Kulanj	25.6	29.9	21.1
Paschim Birgaon	22.3	27.3	16.9
Total/Average:	**25.15**	**29.45**	**20.53**

Source: Bangladesh Population Census 1991

Post Project

In the study area literacy rate is 37.9%, where for male it accounts to 38.4% and female 37.4%. Data confirms that like the national picture of Bangladesh (Male 54.1% and Female 51.8%), in the study area the male populations are more educated than the female counterpart. Attending rate of male is higher than the female students is almost same in pre-school and primary level but attending of female students starts reducing from secondary level as the study area is one of the conservative area in Bangladesh. Parents are more concuss aboutr female education. Literacy rate of the studied population is presented in Table 8.4

Table 8.4: Literacy Rate in the Study Area

Union	Literacy Rate		
	Both	Male	Female
Jagaddal	36.5	37.3	35.7
Karimpur	42.5	42.3	42.6
Kulanj	37.3	38.3	36.3
Paschim Birgaon	35.5	35.8	35.1
Total/Average:	**37.9**	**38.4**	**37.4**

Impact

However, as mentioned earlier that male-female attendance ratio is almost equal with a little difference at primary level in which female attendance is comparatively higher than that of males. Field findings confirm that female attendance at this stage is higher because of existing scholarship program, and the parents also consider this basic schooling as an investment for securing a good marriage of their girl child, decries of social barrier, parents are more aware about female education. It has also been observed and our data confirms that post completion of primary education, most of the girls get married and therefore the attendance rate gradually starts decreasing. However, male attendance rate is decreasing due to their involvement in income generating activities.

Figure 8.6: Picture of the Chaptir Haor Area (Karimpur GPS and Karimpur High School)

8.4.4 Health and Sanitation

Pre Project

There was about 32 tubewells (each para/mohallahin had 1 tubewell) this area during 20 – 22 years back. So they had a great problem of drinking water. On that time most of the people had face great problem for pure drinking water. They used alternative sources like river water for drinking purpose. Taking a bath, cooking and other domestic activities are done with the water of River (Kalni) and beel (Tatua beel, Kuncha beel, Tetlyanmyda beel). About 80% people use hung toilets made of bamboo and the rests 15 % use open fields or bushes to meet the natural essentials. People take Haor water during working and fishing in the Haor. There are only 5-10% household have tube wells in the village and pre '95 and almost all the people took river or Haor water.

The villagers were suffered with cold fever, fever, flue, malaria, chicken pox, diarrhoea, TB, jaundis, gastric ulcer, paralysis, and so on. There had been no medical amenities in the area on that time. The villagers took *kaviraji* treatment (traditional treatment) for any kind of sickness. Besides, they were used to go to the village and quack doctors for any treatment and if very serious case they to Upazila (Derai) and District (Sunamganj and Sylhet) level hospitals. Treatment service was also very insufficient. During the monsoon and in case of violent wind it was not possible for them to go there through stormy and wave Haor. On the other hand, during the dry season due to the lack of transport facilities people were facing troubles to go to upazila or district level hospitals for treatment.

Post Project

Now a days people are suffering cancer, heart disease, diabetes mellitus, Chronic Obstructive Pulmonary disease, mental health problems and women's diseases (pregnancy, breast and uterine cancer). Medical facilities and services are now more easier than previous period like community clinic, union health centre, private clinic and upazila health complex and district hospital. Sanitation facilities in the study area show that about 5.3% households use non-sanitary latrines, 27.6% use non water-sealed sanitary latrines and 56.1% use none latrines. Field findings confirm that non-sanitary latrines are predominant among kutcha houses. As non-water-sealed sanitary latrines are used by kutcha, semi-pucka and pucka households, it contains the highest coverage (30.0%). Water-sealed sanitary latrines are available predominantly in pucka houses, it contains the highest coverage (7.4%). However, there are 11% houses, which have no sanitation facilities but tend to use on shared basis and in some cases uses open spaces (Table 8.5).

Table 8.5: Toilet Facilities in the Study Area

Union	Toilet Facility (%)			
	Sanitary (water-sealed)	Sanitary (non water-sealed)	Non-sanitary	None
Jagaddal	6.0	30.0	51.4	12.6
Karimpur	7.4	27.8	53.9	10.9
Kulanj	1.9	23.7	61.9	12.4
Paschim Birgaon	5.8	28.9	57.3	8.0
Total/Average:	**5.3**	**27.6**	**56.1**	**11.0**

Source: Population and Housing Census 2011, BBS, 2012

Figure 8.7: Sakitpur Community Clinic and Sanitation System

Impact

The situation is compounded by flash floods, which are a major threat to health and sanitation. Usually the Haor area is flooded from May to October. Most of the tube wells and toilet are go underwater during monsoon and flood periods, creating scarcity of drinking water and threatening the health of the Haor community. Moreover, the scenario were decrying/changing post implementation the projects. It’s a good sign of positive impact.

8.4.5 Communication and Transport

Pre Project

There is a famous saying in the Haor area to describe the means of transportation "*Borsha kale naoa ar shukna kale pao*", which literally means "boats during monsoon and feet during dry season-". Haor areas remain under water for 4-6 months during the pre-monsoon and monsoon season. The roads are submerged during this period making it impossible to travel from one place to other (Kakitpur to Derai bazaar, Karimpur to Derai bazaar, Jagaddal to Derai and Dakshin Nagargaon to Derai upazila) pre using boats. Pre intervention, there had no defined road network inside the Haor except the compartment (*Ayle*) of crop land. In the dry season, people use bicycle or foot for transportation, sometimes people from another Haor area come to this Haor through Main River and local channels. Big sized launches, ships, barges usually run in the river.

Overall 15 km of road networks exist in the study area unions where 1 km roads was brick soling road and 12 km roads were earthen.The average numbers of passengers travelling daily are 650 of which 75% travel in non-motorized vehicles and the rest in motorized vehicles.

Figure 8.8: Communication in the Study Area at Karimpur Union

Post Project

The water way communication is not effective during dry season. The transportation network and the waterway and roadway have developed over the years in keeping with the unique characteristics of Haor. The rural roads consisting of upazila, union and village roads are constructed by the Local Government Engineering Department (LGED), Local government. The BWDB submersible and compartmental embankments were playing main role in communicate on though this was damaged post each flood. The water way communication was not effective during dry season.

Overall 20 km of road networks exist in the study area unions where 3 km roads are submerged road (*pucka*), 17 km roads are earthen(submerged road), Karimpur, Chandpur, Sakibpur to Derai road (about 3 km.) is the main road network in the Haor area. Most of the people use this road as a way of communication and goods transportation. In this connection, people use small motorized and non-motorized boat for communication with nearest village market/bazaar, union and upazila town, carrying their commodities. The villagers use in dry season for travelling from one place to another with non-motorized and motorized vehicles. There is no road network surrounding the Haor. People used earthen road as the way of communication.

Impact

The communication is improved as this Haor is very close to the Derai Upazila HQ Derai. The BWDB’s submersible and compartmental embankments are playing main role in communication. But this was damaged post each flood. The natural causes for the degradation of the transportation system are flash floods, Afal or wave erosion, annual inundation, water logging, siltation and sedimentation. Now a day, due to eroding the submerged road adjacent of the Kalni River. In the mid season (October to November) sufferings of the people became begger’s description because villagers could not properly used through boats or motorized vehicles. The transport system influence the socio-economic velnerabality. Proper and protected road network as well as the water way communication is essential to ensure the overall socio-economic development of the Haor people. The communication system is improving gradually by demand of population and aftrer inrtervention.

8.4.6 Local Social Dynamic

There is conflict of interest in the area mainly between farmers and fishermen. Pre intervention, the conflict of interest was not noticeable but with the project intervention the conflict has emerged. According to the local people, due to the interventions, at present some areas have become water logged and some are congested by drainage obstacles. The lease holders of the *jolmohal* are prolonging the drainage congestion and water logged situation as they can capture more fish out of it. In contrast, the agricultural group wants to pass away the water through the river or canal to get rid of water logging. This is the biggest conflict at this moment of the area in between the farmers and the lease holders of *Jolmohal*. In order to reduce the conflict significantly, considerable remodelling of the rehabilitation work is needed.

Impact

Sometimes social unrest situation emerged due to the control of water management.

9. Summary of Impacts

9.1 Summary of Impacts

Indicators	Pre-project	Post-project	Impact
Water Resources			
Flooding	Flood water entered in and went away properly before the interventions. All the area flooded equally and water drained down timely.	The timing of presence of water has increased after the intervention. Water is said to take more time for drainage than before.	Climate change has played a role flooding as the pattern of flash flood has changed a lot. Uneven flooding owing to the interventions has also been regarded as a problem generated by the interventions.
Drainage	The drainage condition in the Chaptir Haor was said to be natural before the interventions. Water did not face any complication at the time of departure.	After the interventions, water is taking time to drain down from the haor as silt has reduced the conveyance capacity of the Chamti Khal that is the main path for drainage.	Water drainage has reduced the time to take preparation for the pre-works for agriculture. Villages inside the haor also remains under water for longer period due to drainage problem.
Sedimentation and Siltation	The direct effect of sedimentation was not apparent before the interventions. River, channel and haor beds were free from sedimentation.	After the interventions, river, channel, beel and haor beds are getting filled up with sedimentation. Water conveyance capacity has decreased dramatically and causing problem for the drainage of the water.	Sedimentation is probably the biggest problem in Chaptir Haor. This has created negative impact on water drainage, agriculture and navigation. Dredging has never done in the haor and this is why the problem is getting intense day by day.
Erosion	Erosion due to wave action was severe before the interventions. Villages were vulnerable to erosion and banks of the villages got hit by the wave and thus degraded.	Effect of erosion has lessened after the interventions. Only some rural roads constructed by the local government has become victims of wave action and erosion after the interventions.	The impact of wave action and erosion after the interventions has been regarded as positive as people in the haor do not face erosion to their property.
Land Resources			
Land use (ha)	• Gross area:5,065 • NCA:4,408 • Others:657	• Gross area:5,065 • NCA:4,452 • Others:613	• NCA:+44 • Others:-44
Land degradation	No	No change	No change
Agriculture Resources			

Indicators	Pre-project	Post-project	Impact
Cropping intensity (%)	100	100	No change
Cropped area (ha)	• Rice: 4,408 (Boro: 4,408) • Non Rice: 0	• Rice: 4,452 (Boro: 4,452) • Non Rice: 0	• Rice:+44 (Boro: +44) • Non Rice: 0
Crop production (ton)	• Rice: 13,936 (Boro: 13,936) • Non Rice: 0	• Rice: 19,816 (Boro: 19,816) • Non Rice: 0	• Rice:+5,880 (Boro: +5,880) • Non Rice: 0
Crop damage (ton)	• Rice: 2,032 • Non Rice: 0	• Rice: 2,550 • Non Rice: 0	• Rice:+518 • Non Rice: 0
Irrigated area (ha)	• Rice: 4,408 • Non Rice: 0	• Rice: 4,452 • Non Rice: 0	• Rice:+44 • Non Rice: 0
Surface water Irrigation availability	Available	Deficit during month of February to March	Deficit
Agro-chemicals use (ton or kiloliter)	• Fertilizers: 0 • Pesticides: 0	• Fertilizers: 942 • Pesticides: • Liquid:1.197 • Granular:19	• Fertilizers:+ 942 • Pesticides: • Liquid:+1.197 • Granular:+19
Livestock Resources			
Livestock population (number)	• Cattle:5,610 • Goat:490 • Duck:9,880 • Chicken:10,950	• Cattle:7,240 • Goat:380 • Duck:8,000 • Chicken:14,270	• Cattle:+1630 • Goat:-110 • Duck:-1,880 • Chicken: 3,320
Fisheries Resources			
Fish habitat area	Total fish habitat 4,538 ha • River and Khal- 78 • Perennial Beel- 51 ha • Floodplain- 4,408 ha.	Total fish habitat 650 ha, • River and Khal- 81 • Perennial Beel- 9 ha • Floodplain- 4,452 ha. • Extensive Fish Pond- 8 ha	• Increased perennial water body by 12 ha
Fish habitat Condition	• Habitat suitability condition and quality was good for active swimmer group of fish and • Some beel /area was untouched from fishing. That helps for next year recruitment of fishes.	• Habitat condition become somewhat unsuitable for active swimmer group and SIS of fish at water control structures • Decreasing of perennial water area because of lacking proper fisheries management practces.	• Decreasing water depth results in increasing critical water velocity (particularly for SIS of fishes) at critical water depth for increasing discharges during pre-monsoon period • Breeding and spawning ground of beel resident fishes has been shrinkage
Fish Diversity	• Fish species were more or less of evenly distributed over the year	• Active swimmer group and SIS of fishes become unavailable in some extent	• Active swimmer group and SIS of fishes become unavailable in some extent

Indicators	Pre-project	Post-project	Impact
		• Culturable fish species become more available in haor area	
Fish migration	• Comparatively undisturbed of fish migration.	• Disrupted due to raising of khal and beel bed in some extent • Disturbed pre-monsoon lateral migration of brood fishes caused due to regulators, sluice gate and culverts	• Disrupted due to increased siltation, regulators, sluice gate and culverts.
Fish production, Metric Ton / Year (MT/ Year).	Total fish production 394 MT. • River and Khal- 18 MT • Perennial Beel- 23 MT • Floodplain- 353 MT.	Total fish production 1,597 MT. • River and Khal- 18 MT • Perennial Beel- 9 MT • Floodplain- 1,558 MT • Extensive Fish Pond- 11 MT.	• Overall fish production has been increased by 1,203 MT. *(Fish production rate mention below of this table).
Fishing Appliance	• Mesh size of net above 1 inch was used to catch fishes. • Use of Kona jal /moshari jal (small mesh size net) was not noticed.	• Using of small mesh size net like kona jal / mosquito net (mesh below 1 cm) and catches all small become highly available • Fishing pressure at the mouth of the water control structures was increased	• Increased fishing pressure at the mouth of the water control structures
Ecosystem			
Terrestrial flora	Floral coverage of indicator species in homestead diversity was not notable but in kand area is notable.	Floral diversity (kadam-*Neolamarckia cadamba*, rendee- *samania saman*) enriched specially on homesteads and decreased kanda vegetation (karach (*Millettia pinnata)*, pitali (*Trewia nudiflora)*, barun (*Crateva magna)*, hijal (*Barringtonia acutangula)*	The indicator floral coverage is changed.
Terrestrial fauna	Faunal indicator species (Brahmini Kite, White-rumped Vulture, Indian Bull Frog, Cricket Frog, Monocellate Cobra, Bengal Monitor, and Golden Jackal)	Faunal diversity and population of faunal indicator species has been reduced, locally diapered (White-rumped vulture, Fishing Cat, Large Indian Civet) due to agricultural expansion,	Diversity and population of indicator terrestrial fauna has been reduced over time.

Indicators	Pre-project	Post-project	Impact
	population were pretty high.	planting exotic and other human interference.	
Aquatic flora	Aquatic floral coverage was enriched especially rooted floating plants (makhna- *Euryale ferox*, singra-*Trapa maximowiczii*, chalia gash- *Hemarthria protensa*).	Due to over extraction, agriculture expansion and other anthropogenic activities makhana (*Euryale ferox*), singra (*Trapa maximowiczii*) and nolkhagra (*Phragmites karka*) has been locally disappeared.	Indicator species like (makhna- *Euryale ferox*, singra- *Trapa maximowiczii*, chalia gash- *Hemarthria protensa*) has been locally disappeared.
Aquatic fauna	Aquatic faunal species and population were enriched throughout the area. Presence of Ganges River Dolphin.	Aquatic faunal communities have changed specially the turtle and dolphin migration and otter population.	Indicator faunal diversity and population especially the turtle, mammals population are significantly changed. Dolphin migration has been closed to closure at kalni river outfall at Markuli point.
Swamp Forest and Reed land	No swamp forest but reeds coverage especially on *Phragmites karka*, *Xanthium indicum*, *Calamus longisetus*, *Vetiveria zizanioides*, *Imperata cylindrical*) etc. and their density were enriched.	Reduced of swamp bush and reed land density and coverage	Harvesting of economically valuable plants reed land has converted to agricultural land.
Ecosystem goods and services	Ecosystem goods and services were in optimum level.	Ecosystem goods and services have been reduced over time for different anthropogenic activities.	Ecosystem goods and services have changed.
Socio-economic Conditions			
Employment Opportunity	Total cropped area was 4408 ha where about 534240 man days labor input were needed.	Total cropped area were 4452 ha where about 712320 man days labour input were needed when there was no technological use but post the technological use labor input reduced up to 33.3%.	On an average about 45% labour input has increased for the intervention pre technological use in the area. But post the technological use the labor input has reduced up to 33.3%. Now a day's some people are involved in other occupations like fishing, sand and stone labor, coal

Indicators	Pre-project	Post-project	Impact
			laboring, transportation and so on. Some people migrated to other areas of greater Sylhet, Gazipur, Dhaka, Chittagong in search of better fortune.
Gross Income from crop production	Annual crop production was 13936 tons which net value was approximately 29.8 corer at present market price	Annual crop productions were increased to 19816 tons of which net value is approximately tk 42.41 corers.	Additional 5880 tons crops were produced which net value is approximately tk 12.58 corer and near about two times from the base situation.
Housing condition	The Haor area's households was predominantly made of straw/Bamboo (60%), tile/C.I sheet and combination of different types of materials household was 39% and Cement was 1%..	About 79 percent live in kutcha where 12 percent live in semi pucka, 5 percent in pucka and 3 percent live in jhupri.	The Pucka and semi pucka households increase (12% semi pucka & 5% pucka). Post the intervention the rice production has increase and many landless laborer started to sharecrop. The landless farmers gained some extra income opportunity which helped to improve their housing condition.
Health and Sanitation	The Haor had a great problem of drinking water. On that time most of the people had face great problem for pure/safe drinking water. They used alternative sources like river water for drinking purpose. Taking a bath, cooking and other domestic activities are done with the water of River (Kalni) and beel. About 80% people use hung toilets made of bamboo and the rests 15 % use open fields or bushes to meet the natural essentials. The villagers took kaviraji treatment (traditional treatment) for any kind of sickness. Besides, they were used to go to the village and quack	Medical facilities and services are now more easier than previous period like community clinic, union health centre, private clinic and upazila health complex and district hospital. Sanitation facilities in the study area show that about 5.3% households use non-sanitary latrines, 27.6% use non water-sealed sanitary latrines and 56.1% use none latrines.	Most of the tube wells and toilet are go underwater during monsoon and flood periods, creating scarcity of drinking water and threatening the health of the Haor community. alternate sources of drinking water supply such as the Pond Sand Filter (PSF), ring wells, Rainwater Harvesting system (RWH) etc.have been still insufficiently available or used in the area, especially during flood periods. Moreover, the scenario were decring/changing post implementation the projects. It's a good sign of positive impact.

Indicators	Pre-project	Post-project	Impact
	doctors for any treatment. It was not possible for them to go there through stormy and afal/wave Haor.		
Communication and Transport	Haor areas remain under water for 4-6 months during the pre-monsoon and monsoon season. The roads are submerged during this period making it impossible to travel from one place to other. Pre intervention, there had no defined road network inside the Haor except the compartment (Ayle) of crop land. In the dry season, people use bicycle or foot for transportation, sometimes people from another Haor area come to this Haor through Main River and local channels. Big sized launches, ships, barges usually run in the river.	The BWDB submersible and compartmental embankments were playing main role in communicate on though this was damaged post each flood. The water way communication was not effective during dry season. People use small motorized and non-motorized boat for communication with nearest village market/bazaar, union and upazila town, carrying their commodities. The villagers use in dry season for travelling from one place to another with non-motorized and motorized vehicles. There is no road network surrounding the Haor.	The communication is improved as this Haor is very close to the Derai Upazila HQ. The BWDB's submersible and compartmental embankments are playing main role in communication. But this was damaged post each flood. . Now a day, due to eroding the submerged road adjacent of the Kalni River. In the mid season (October to November) sufferings of the people became begger's description because villagers could not properly used through boats or motorized vehicles. The communication system is improving gradually by demand of population and aftrer inrtervention.

10. Environmental Management Plan

10.1 Management Plan

Impact	Mitigation Measures	Enhancement Measures
Flooding	• The construction of the embankment should be done within February month • The embankment of the haor should be elevated up to 5 feet if possible • Proper supervision should be provided during the construction of the embankment • An embankment should be provided on the bank of Chamti River/Khal	
Drainage and Sedimentation	• Sluice gates and regulators should be renovated and made free from sediment • Dredging should be done in the beds of Kalni, Kushiara and other rivers and channels	
Navigation	• Proper boat passage should be placed in the embankments • The estuary of Kalni River should always be open for the passage of water	
Land use change	-	• Agricultural land graving should be avoided.
Increased cropped area	-	• Kanda should be utilized for vegetables cultivation. • Hydroponics or floating bed vegetables cultivation should be introduced. • Medium low land should be utilized for short duration and submergence tolerant T Aman (BINA dhan7, BINA dhan 11, BINA dhan12 and BINA dhan 13) cultivation. • Flood tolerant submergence variety (BRRI dhan51, BRRI dhan52 and BRRI dhan79 may be tested.
Increased crop production	-	• Crop area should be increased by utilization of fallow land. • Short duration high yielding and hybrid varieties should be developed/introduced/strengthened.

Impact	Mitigation Measures	Enhancement Measures
		• Crop damage should be minimized by timely and proper rehabilitation of water control structures like embankment, compartmental embankment, pipe sluices and regulators etc. • Involvement of Project Implementation Committee (PIC) on rehabilitation works should be increased
Increased irrigated area and availability of irrigation water	• Regular re-excavation/dredging of Surma, Chamti and Kalni river and linked with the haor and other adjacent haors. This will improve the overall water management system of this haor.	▪ Re-excavation of existing beels and khals should be ensured for retention of irrigation water. ▪ Re-excavation of Chamti and Kalni river, khals and Kuncha beel for water reservoir. ▪ Additional Irrigation inlet should be installed due to more coverage of irrigation area. ▪ Irrigation water should be ensured by stopping drainout the beels during early dry season for fish harvesting.
Status of livestock/poultry		• Grazing area should be increased by utilizing fallow land. • Awareness build up through training • Marketing facilities should be improved. • Availability of high yielding breed should be ensured.
Increased crop damage	• Strengthening the submersible embankment through repairing of embankment. • Rehabilitation work should be done at a time on entire submersible embankment. • Rehabilitation work of embankment should be done within the month of December to February. • Raise the height of the submersible embankment up to 2 to 3 feet higher than the present height at vulnerable locations. • The number of vent should be increased in the regulator on Chamti river. • Boat pass regulator of the Chandpur mouza should be improved	-

Impact	Mitigation Measures	Enhancement Measures
	• Regular dredging of the rivers has to be ensured in order to reduce the intensity of flash flood. • Rehabilitation works should be finished by February • Quality materials should be used for rehabilitation works. ▪ Short duration high yielding or hybrid varieties should be used instead of long duration BRRI dhan29 variety. ▪ Local varieties should be transplanted in the deeper part of the haor area instead of short height high yielding or hybrid variety.	
Increased use of agro-chemicals	• Farmers should be encouraged to use organic manure to increase soil fertility while avoiding water contamination and reduce the soil fertility. • Farmers should be encouraged to cultivate leguminous crops to enhance the soil quality. • Farmer should be follow modern agricultural technology like Integrated Pest Management/Integrated Crop Management(IPM/ ICM), Good Agricultural Practices (GAP) etc.	-
Decrease the fish habitat condition and quality	• Increase the water holding capacity in khals through re-excavation/ dredging. • Maintain minimum 1 m water depth during dry season for all water bodies • Tatua beel need to be conserved through declaring fish sanctuary	• Maintenance work should be conducted of certain interval to keep optimum level of water in the khal and river. • Monitoring should be conducted through fishers' communities by the guidance of upazila fisheries officer.
Hampering of fish migration and spawning	• Increase the conveyance capacity of Khal maintaining minimum 1 m depth during dry season; • Should bring fish friendliness in the existing fish pass structures and new structures should be fish friendly. Structures should be Khal's width-wide, roughness of the structure wall & bottom, water retention at minimum 1m depth in the dry season, etc.	• Proper maintenance work should be conducted and monitored by the Project Implementation Committee (PIC). • Monitoring and awareness building activities should be conducted through fishers' communities under the guidance of Upazila Fisheries Officer.

Impact	Mitigation Measures	Enhancement Measures
	• Fishing should be controlled during pre-monsoon and recession period.	
Increase the fisher's involvement in fishing at the mouth of the regulators, sluice gates and culvert	• Fishing should be banded during pre-monsoon and last post-monsoon	• Monitoring and awareness building activities should be conducted through fishers' communities by the guidance of upazila fisheries officer.
Decreasing of fish species and species abundance	• Use of small mesh size net should be banded. • Perennial beel namely Tetua Beel should be selected as protected /non-fishing beel round the year.	• The protected area should be guarded especially at night by the professional fishers of adjacent village for incremental fish production. • Management committee should be formed by the fishers and other community members by the guidance of Derai Upazila Fisheries Officer. Use of sign board and red flag to indicate the protected area. And the area should be guarded especially at night by the professional fishers of adjacent village.
The indicator floral coverage is changed.	• Plantation of local species (i.e. Karoch -Millettia pinnata, Pitali - Trewia nudiflora, Baroon- Crateva magna, Hizaal - Barringtonia acutangula Ficus hispidaetc.) as early as possible. • Use of natural fertilizer such as cow dung, compost etc.	• Initiate plantation programme (suggested species) along the river levees, kandas and other khash lands with the attachment of plant specialist.
Diversity and population of indicator terrestrial fauna has been reduced over time.	• Identify core habitat for the threatened animals (Fishing Cat- Prionailurus viverrinus, Small Indian Civet- Viverricula indica, Bengal Monitor- Varanus bengalensis Jungle Cat-Felis chaus etc) and take action to conserve the respective habitats. • Aware local people to avoid wildlife killing	• Aware local people for conserving specially threatened suggested wildlife species of this haor area under the supervision of a wildlife specialist.
Indicator species like (makhna- *Euryale ferox*, singra- *Trapa maximowiczii*, chalia gash- *Hemarthria*	• Aware local people about the importance of aquatic resources • Sustainable harvesting of aquatic species and re-introduction of singra, makha from the beels	• Preserved important beels for aquatic biota conservation.

Impact	Mitigation Measures	Enhancement Measures
protensa) has been locally disappeared.	(mela beel, ulauli beel, tiura beel etc.).	
Indicator faunal diversity and population especially the turtle, mammals population are significantly changed. Dolphin migration has been closed due to closure at kalni river outfall at Markuli point.	• Aware local people about conservation of aquatic animals and their sustainable harvesting of aquatic flora. • Avoid hunting of the turtles (Spotted Flap-shelled Turtle - Lissemys punctata, Peacock Soft-shelled Turtle-Nilssonia hurum) • Identify core habitat for the threatened animals and take action to conserve the respective habitats. • Ensure dolphin pass instead of closure at kalni outfall at Markuli point.	• Aware local people for conserving specially threatened wildlife species of this haor area under the supervision of plant and wildlife specialists.
Harvesting of economically valuable plants reed land has converted to agricultural land.	• All the khash land with swamp bush and reed lands should be out of public lease and allotments.	• Local household should be involved in nursery program for proper seed germination and saplings collection. • BWDB, local people, local nursery owner should be properly involved (under participatory approach) in the collaboration of plantation program inside the haor area. • Create new swamp forest area.
Ecosystem goods and services have changed.	• Conservation of reed land and important wetland areas. • Avoid over harvesting of economically valuable plants such as (Bet -Calamus longisetus), panibaz- Salix tetrasperma) • Use of natural fertilizer such as cow dung and compost.	• Eco friendly tourism according the relevant policy and laws • Alternative livelihood to be created through provision of appropriate training among Haor based community.
Employment and income generation	-	• Train up Haor people about alternative employment and income generation • Provide soft lone to the real farmers • Allocation all the beel /jallmohal to the actual fishermen • Build up linkage with farmer and national, international traders
Health and sanitation	-	• Awareness should be built up about sanitation among the local people. • Toilet must be always clean in daily basis

Impact	Mitigation Measures	Enhancement Measures
		• Providing training of the villagers about health and sanitation, • Dissemination the messages on best hygienic practices by family level • Tubewells and toilet built up in the high land
Communication and Transport	• Embankment repairing work to be done in such a way that people can use it for transportation. • Involvement of water management committee for the repairing plan • Provide legal authority for monitoring the repairing workthrough the water management committee	• Use of local labour for the repairmen of the embankments

Appendix A

Table A1: Availability of Major Fish Species in Chaptir Haor

Sl.	Local name of fish	Scientific name of Fishes	IUCN Status	Post-Project	Pre-Project
1	Ayre	*Sperata aor*	VU	0.24	0.24
2	Bacha	*Eutropiichthys vacha*	LC	0.85	0.81
3	Baghair	*Bagarius bagarius*	CR	0.16	0.16
4	Baila	*Glossogobius giurus*	LC	0.34	0.33
5	Bajari Tengra	*Mystus tengara*	LC	2.19	2.13
7	Barobaim	*Mastacembalus armatus*	EN	0.32	0.32
10	Boal	*Wallago attu*	VU	2.38	2.34
11	Catla	*Catla catla*	LC	1.37	2.08
14	Chapila	*Gudusia chapra*	VU	0.44	0.48
15	Chang	*Chana orientalis*	LC	0.97	0.97
18	Chital	*Chittala chittala*	EN	0.67	0.70
19	Darkina	*Esomus dandicus*	LC	0.80	0.82
26	Ghoinya	*Labeo gonia*	NT	2.04	1.98
29	Gojar	*Channa marulius*	EN	0.56	0.60
33	Gutum	*Lepidocephalichthys guntea*	LC	0.70	0.70
34	Kabashi tengra	*Mystus cabasius*	NT	0.58	0.61
35	Kachki	*Corica soborna*	LC	0.79	0.79
36	Kaikla	*Xenentodon cancila*	LC	0.63	0.66
37	Kajuli	*Ailia coila*	LC	0.45	0.43
38	Kalibaus	*Labeo calbasu*	LC	0.87	0.87
40	Kanipabda	*Ompok bimaculus*	EN	1.52	1.50
42	Kashkhaira	*Chela laubuca*	LC	0.60	0.64
43	Katari Chela	*Salmostoma bacaila*	LC	0.54	0.58
44	Kholisa	*Colisa fasciatus*	-	0.73	0.77
47	Koi	*Anabas testudineus*	LC	0.80	0.83
48	Kuchia	*Monopterus cuchia*	VU	0.73	0.77

Sl.	Local name of fish	Scientific name of Fishes	IUCN Status	Post-Project	Pre-Project
50	LalChanda	*Chanda ranga*	-	0.87	0.90
51	Lal kholisa	*Colisa lalius*	-	0.36	0.36
52	Magur	*Clarias batrachus*	LC	0.82	0.86
53	Mrigal	*Cirrhinus mrigala*	NT	1.10	1.10
55	Mola	*Amblyphayngodon mola*	LC	1.65	1.83
58	Nandil, Nandi, Nandina	*Labeo nandina*	CR	0.84	0.88
59	Napit koi	*Badisbadis*	NT	0.90	0.93
64	Potka	*Tetradon cutcutia*	LC	0.96	0.99
68	Rani	*Botia dario*	EN	0.90	0.93
70	Rita	*Rita rita*	EN	0.93	0.96
71	Rui	*Labeo rohita*	LC	1.35	1.52
72	Shilong	*Silonia silondia*	LC	0.99	1.05
73	Shing	*Heteropneus fossilies*	LC	1.00	1.07
74	Shol	*Channa striatus*	LC	1.04	1.10
77	Tara baim	*Macrognathus aculatus*	NT	1.16	1.20
78	Tengra	*Mystus vittatus*	LC	2.19	2.13
80	Tit puti	*Puntius ticto*	LC	2.23	2.18
81	Veda/Mani	*Nandus nandus*	NT	0.82	0.82

Appendix B

Table B1: Breeding and Spawning Period, Habitat Requirement and Available Habitats in Chaptir Haor

Fish Species	Critical Period (Month)		Habitat Requirement	Available Breeding/SpawningGround	
	Breeding	Spawning		Pre Project	Post Project
Gonia, Boal, Air, Baghair, Shole, Kalibaus, Taki, Shing, Magur, etc	Mid-March to Mid-June	Mid-April to Mid-July	**Water Depth** 1.5 to 3ft **Water Velocity** Near to Zero **Vegetation** Durba, Chailla and NalKhagra **Substrate Type** Sandy Loam	• Kalni River • TatuaBeel • HatniBeel • FeluaBeel • Tetlyanmayda Beel • Bali Beel • Kanda area of Floodplain • Surrounding area of household	**River and Khal** • Kalni River • ChamtiKhal • DalarKhal • DulniKhal **Beel** • Tatua • Hatni • Felua • Tetlyanmayda • Bali • Kuncha • Chhanchatla/Sandua • Dobaura/Goinnafukrai • Kakchira • Kanda area of Floodplain • Surrounding area of household
Rani	Mid-March to Mid-June	All the year round	**Water Depth** 1ft **Water Velocity** Low (<0.02m/s) **Vegetation** NA **Substrate Type** Clay ***N.B.:*** This fish species make hole in shallow bottom slope of the river and Kanda land (Highland on the haor) and hatch there	• Kalni River • ChamtiKhal • Kanda area of Floodplain	• Kalni River • Chamti Khal • Dalar Khal • Dulni Khal • Kanda area of Floodplain
Khas Khoyra, Tit Punti, etc. Barb Fishes	Mid-March to Mid-May	Mid-April to -August	**Requirements** • *Type:* Marginal Fish	• Kanda area ofFloodplain • Surrounding area of household	• Kanda area of Floodplain • Surrounding area of household

Fish Species	Critical Period (Month)		Habitat Requirement	Available Breeding/SpawningGround	
	Breeding	Spawning		Pre Project	Post Project
			• *Water Velocity:*Low to Moderate • *Water Depth:*<2ft • *Vegetation:* NA • *Substrate Type:* Sandy Loam		
Napit Koi, Koi, Khoilsha, Boicha	Mid-March to Mid-May	Mid-April to -August	**Requirements** • *Type:* Marginal Fish • *Water Velocity:*Low to Moderate • *Water Depth:*<2ft • *Vegetation:* NA • *Substrate Type:* Sandy Loam	• Kanda area of Floodplain • Surrounding area of household	• Kanda area of Floodplain • Surrounding area of household

Appendix C: Photo Album

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Chayer Haor

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1 Introduction

1.1 General Information

The Chayer Haor project is located in between 24°36'16.45" and 24°44'12.01" latitude and between 91°09'18.93" and 91°16'42.3" and lies within Sunamgonj, Kishorgonj and Netrokona District. The project has a gross area of 8498.24 ha of which about 45.49 ha area is Baor, 422.10 ha area is Herb Dominated Area, only 1.5 ha area is covered with Ponds, 195.31 ha area is occupied by Rivers and Khals, 146.30 ha area is allocated for Rural Settlement and around 7438.17 ha area is covered with Herbaceous Crops. There are three haors adjacent to this project, namely Kalikota haor located at the North and Baram haor at the East and Kairdhala-Ratna haor at the south-east.

The main river connected with Chayer Haor is Surma River which flows along its southern peripheries. Besides, a branch of Surma River known as Mora Gang flows along the north-south direction and Darain and Kalni River is situated at the south eastern side of the haor. There are a number of canals and wetlands inside the Chayer Haor project. Mentionable are *Chayer khal, Dhora-Banga khal, Roar-Mouti khal, Kabila-Andai khal, Kosma-Andai khal, Gowani khal, Fekkar khal, Kurai khal, Hojma khal, Nirala khal* which help to drain out the water of the haor during post monsoon. Moreover, these khals connect the internal beels of the haor. Mentionable beels are Mouti Beel, Chaya Beel, Roar Beel, Kabila Beel, Rouwa Beel, Feukkawa Beel, Kosma Beel, Gokni Beel, Khara Beel, Ghaita Beel, Marigang Beel, Khash Beel and Atra Beel.

1.2 Project Descriptions

Bangladesh Water Development Board (BWDB) implemented the Chayer Haor project with GOB fund. The major physical interventions of the project are submersible embankment some closures and two drainage regulators on several khals. The main objective of the project was to protect Boro crops from early flash flood as well as to protect life and properties from flooding.

The water management infrastructures of the Halir Haor scheme include the following:

- 45 km embankment,
- 2 number of regulators and
- Around 25 kms drainage canal.

1.3 Present Status of the Project Interventions

Most of the interventions including the submergible embankment with regulators inside the project area are operational according to local people. The crest level of the embankment in Niamatpara, Anandapur and Durlavpur was seen to be below the design level and as a result, the water enters the earlier than it is supposed to be. The Sluice gate at Naziapur is 20 years old and sometimes it stars malfunctioning. Also, the regulators are not functioning

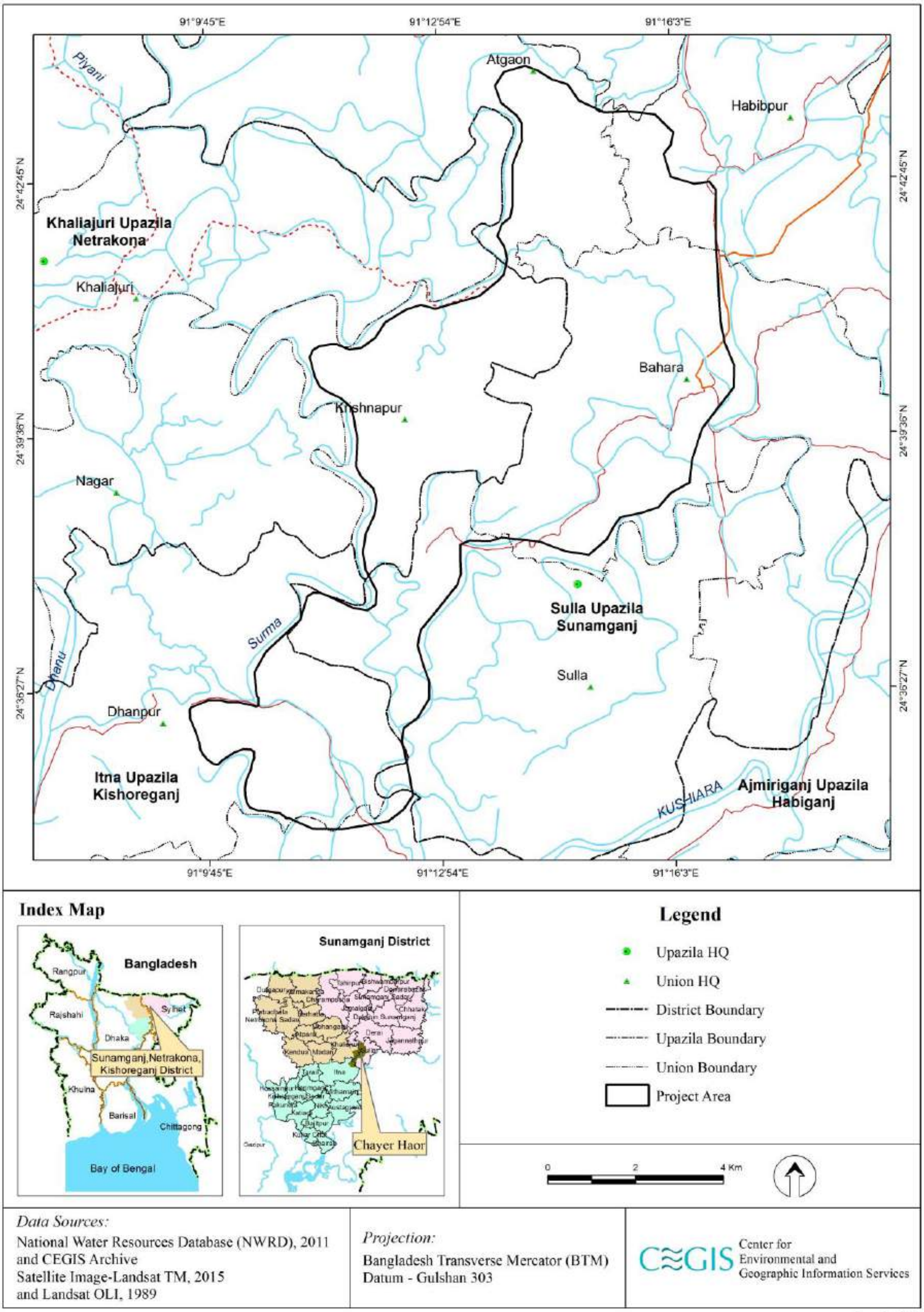

Figure 1.1: Hydrological Features of Chayer Haor System

2 Water Resources

2.1 Flooding Situation

Pre Project

The flash flood normally entered into the haor area through the Surma River and Mora-Gang. In pre-project condition, flash flood frequently entered into the haor during middle of March to early April. This flash flood caused damage to crops and livelihood of the haor populace. To tackle the problem, local people made temporary earthen dams across the khals so that they could harvest their standing crops. Local people informed that the devastating flood in 1988 engulfed the entire project area and caused huge damage to standing crops as well as immense sufferings to the people of this area.

Post Project

After implementation of submersible embankment in Chayer Haor, entrance of flood into haor got delayed by 10-12 days. The flash flood enters through khals as well as by overtopping the submersible embankment in the last week of April and inundates the entire project area within a week. The local people informed that after implementation of the project, they could harvest their crops and safeguard the livelihood due to delayed inundation by the flash flood.

However, the flash flood sometimes comes early due to unprecedented rainfall in the upper catchment in Meghalaya which happened in March 2004 and 2017. The devastating flash flood inundated the entire haor area in the first week of March and damaged all the standing crops. It caused immense sufferings to the local populace. Some segments of the embankment were breached at that time. At present, the crest level of the embankment of Niamatpara, Anandapur and Durlavpur was found to be below the design level. As a result, flood water enters the haor through these areas within seven days which is supposed to enter after 10 to 12 days from its occurrences. As a result, flash flood causes crop damage and sufferings to the people every year.

Figure 2.1: Chayer Haor in the Monsoon Season

Impact

Interventions of the haor have delayed the entrance of flood water by approximately 10-12 days. In recent years, delay of entrance of flash flood has reduced due to delayed repairing of embankment and closing of breaches or public cuts of embankment. Local people demanded that the repairing work should be done within February to avoid the hazard of flash flood.

2.2 Drainage Condition

Pre Project

There are a number of drainage khals inside the Chayer Haor which helped drain out the flood water. According to the local people, in pre-project period most of the flood water could smoothly be drained out to the peripheral rivers through the drainage khals and only some water got retained in the low-lying beels. People made several earthen dams across the internal khals to preserve water for irrigation during dry season. They did not face drainage congestion and water logging problem at large scale before implementation of the interventions.

Post Project

After implementation of the project, the drainage system of the haor has little bit been deteriorated. The flood water is being drained out through the peripheral rivers as well as through Sluice gate at Naziapur which was constructed about 20 years back. This sluice gate does not operate properly as the gate is closed. Local people informed that about 30% areas of Goani, Aditiapur and Keruala Union faces water logging problem for about 13 days. Besides, the upstream region namely Mohammadnagar, Shuklain, Sultanpur and Anandapur Union don't face drainage congestion problem but it got delayed by 5 to 7 days than before. Moreover, earthen dam constructed by local farmers around Mouti Beel slowes down the water velocity towards the low-land. Sometimes local people intentionally cut some segments of the embankment for smooth drainage. BWDB carry out the repairing works of embankment and closures every year to protect from flash flood. Most of the area of the haor gets dried up within last week of January. The internal District roads constructed by LGED does not affect the drainage of the haor area.

Impact

The drainage of the area has become slower than before but not impacting at appreciable extent. Local people demanded sluice gate maintenance for smooth drainage of the area.

2.3 Sedimentation and Siltation

Pre Project

Sedimentation was not a significant issue in this haor. The Surma River carried very low sediment. Hence, sedimentation of this haor was not that much problem before implementation of the interventions.

Post Project

Sedimentation takes places in this haor in natural process. However, sedimentation has taken place in the internal river namely Mora Gang and khals over the years due to slow drainage after monsoon. As a result, the bed levels of the rivers and khals have risen and reduced their conveyance capacity.

Impact

Sedimentation has increased in the peripheral Mora Gang and Surma River as well as internal khals compared to the pre-project condition.

2.4 Navigation

Pre Project

During pre-project period, there was navigational connectivity between the haor and the Surma and Darain River throughout the year.

Post Project

Navigational connectivity of the haor and Peripheral Rivers like Surma, Mora-Gang, and Darain mainly remains operative during monsoon. Besides, navigation also takes operates through the breached points and public cuts before repairing in February/March. Moreover, boats can ply within the haor for fishing and other purposes. Moreover, navigation in the peripheral river has not been affected. However, navigational connectivity does not persist during pre-monsoon due to repair of submersible embankment. Mentionable that communication system has improved tremendously in dry season, due to construction of submergible embankments.

Impact

The navigational connectivity between the haor and the peripheral river has not been affected in monsoon but it does not operate during pre-monsoon. Moreover, navigation in the peripheral river has also not been affected.

3 Land Resources

The project area has fallen in one Agro-ecological zone, namely: Sylhet Basin (AEZ-21). Non-calcareous grey floodplain soil (non-saline) and acid basin clays are the dominant soil. The top soil texture are clay and clay loam; where clay texture is dominant. The soils are slow permeable and have a medium moisture holding capacity. The land type characteristics are not uniform within the project area. About 97% of cultivable areas are low to very low land where minimum flooding depth is above 1.8 meter during the monsoon period. The recession of surface water from most of the agriculture land starts at middle of December and become free of flood water in late January.

Two indicators (Land use and Sand carpeting area) have been selected for assessing the impact on land resources due to structural interventions in Haor ecosystem. The land use and sand carpeting information under pre-project and existing situations were identified through analysis of the available archived satellite images of CEGIS and it was verified through Focus Group Discussion (FGD) and Key Informant Interview (KII).

3.1 Land Use

Pre Project

The gross area of pre project has been considered as similar to post project. The gross area was 8,498 hectare under pre-project situation of which Net Cultivated Area (NCA) was 7,438 hectare. The rest area was covered with water bodies (Baor, Beels, river and Khals), forest (herb, shrub and tree) and rural settlements including homestead vegetation. Details are presented in **Table 3.1**.

Post Project

The gross area remaining same and the Net Cultivated Area (NCA) is 7,427 hectare. The rest area are covered with water bodies (Baor, Beels, river and Khals), forest (herb, shrub and tree), and rural settlements including homestead vegetation. Details are presented in **Table 3.1**.

Impact

Net cultivated area, water bodies and forest area has decreased about 11, 27 and 10 hectare respectively. On the other hand, rural settlements including homestead vegetation area have increased about 40 hectare. Detailed impacted area is presented in **Table 3.1**.

Table 3.1: Detailed Land use in Chayer Haor

Land Use	Pre Project Area (ha)	Post Project Area (ha)	Impact (Post Project-Pre Project)
Net Cropped Area(NCA)	7438	7427	-11
Water bodies	492	465	-27
Forest	422	420	-2
Rural Settlement	146	186	40
Total	**8498**	**8498**	**0**

Sources: Satellite Image-Landsat OLI, 1989 and 2015

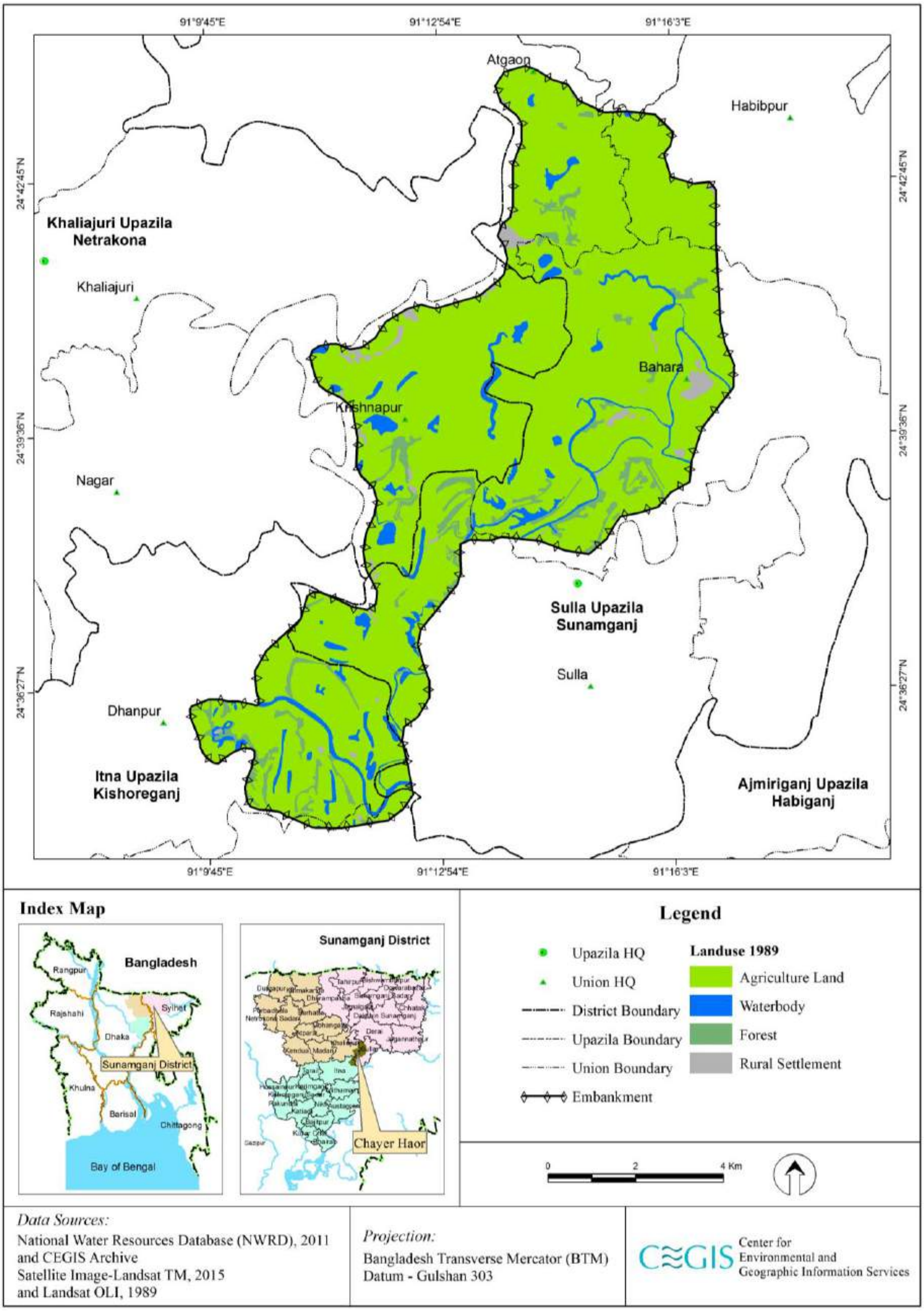

Figure 3.1: Land Use of Chayer Haor System (1989)

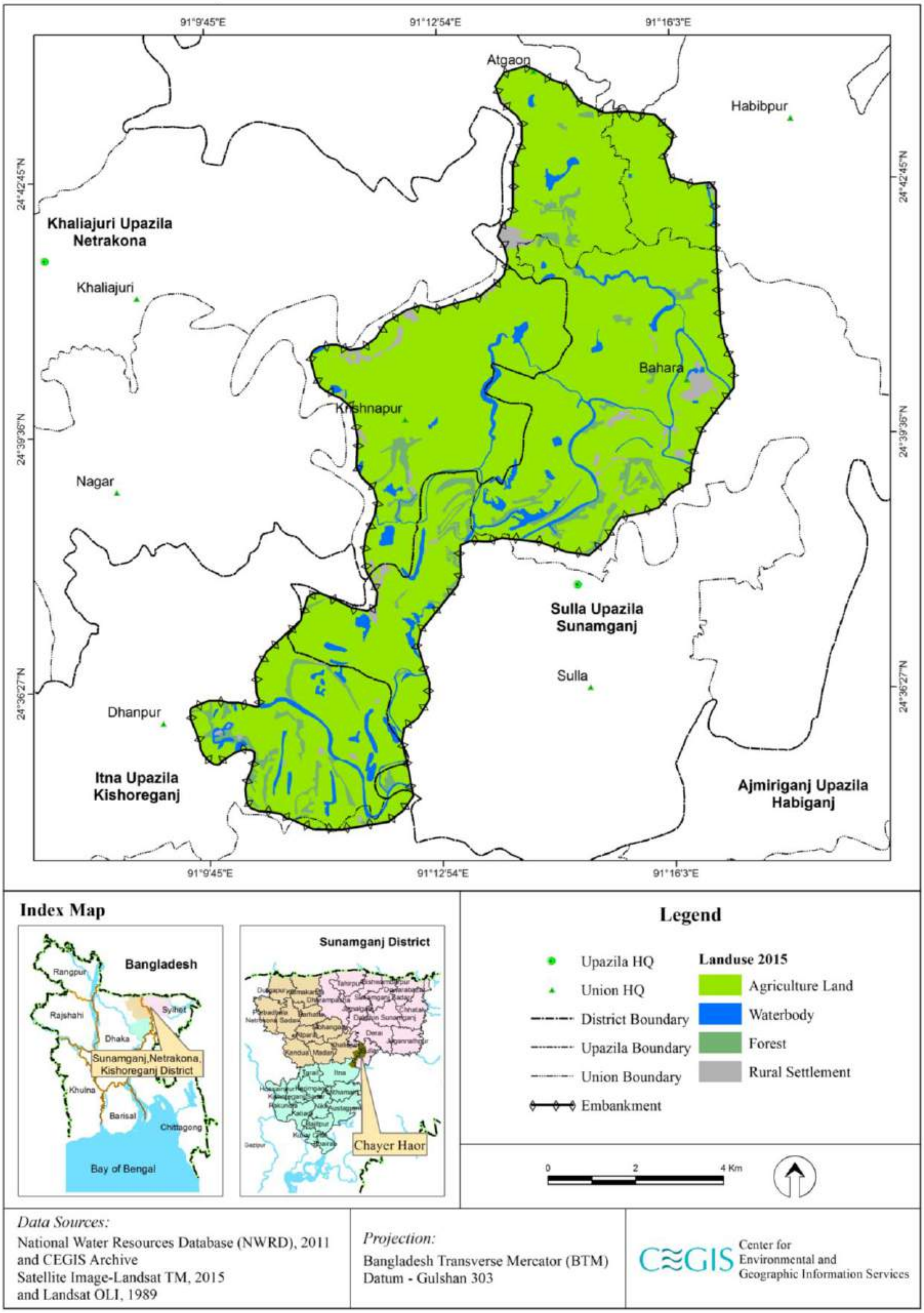

Figure 3.2: Land Use of Chayer Haor System (2005)

3.2 Land Degradation

No sand carpeting was found before or after implementation of the project.

4 Agriculture Resources

Boro rice is the main crop in Haor areas. In most cases, pre-matured or matured Boro crops are damaged by early flash flood which generally happened due to pre-monsoon heavy rainfall in the hilly areas. Besides, drainage congestion and irrigation water scarcity due to siltation of rivers, Khals and Beels are the another problem for Haor agriculture.

Six indicators (cropping intensity, crop area, crop production, crop damage, irrigation and use of agro-chemicals) have been selected for assessing the impact on agriculture resources due to structural interventions in Haor ecosystem. The information of these indicators were collected from both primary and secondary sources. The primary data were gathered from stakeholders through Focus Group Discussion (FGD) and Key Informant Interview (KII). The secondary data were collected from Bangladesh Bureau of Statistics (BBS) and field level Department of Agricultural Extension (DAE) office.

4.1 Cropped Area, Cropping Pattern and Intensity

Pre Project

Before the project interventions, the Net Cultivated Area (NCA) was 7438 hectare, where only one cropping pattern Fallow-Fallow-Local Boro was found. The land type of this project area was low land (about 77%) followed by very low land and low land as presented in **Table 4.1**.

Farmers usually grew Local Boro crops in Rabi season. Different varieties of Boro rice such Gochi, Boro, Tepi Boro and Shail were very much popular among the farmers. Total cultivated area was covered with single cropped area. So, cropping intensity of this area was 100%. Detailed cropping pattern by land type under pre-project situation is presented in **Table 4.1**.

Table 4.1: Pre Project Cropping Pattern in Chayer Haor

Land type	Kharif-I (March-June)	Kharif-II (July-October)	Rabi (November-February)	Area (ha)	% of NCA
Medium Low Land(F_2)	Fallow	Fallow	Local Boro	223	3
Low Land(F_3)	Fallow	Fallow	Local Boro	5727	77
Very Low Land(F_4)	Fallow	Fallow	Local Boro	1488	20
			Total	**7438**	**100**
			Cropping Intensity (%)	**100**	

Sources: CEGIS estimation based on field information, October; 2017

Post Project

The project area became protected from early flash flood due to the interventions, which influence farmers to grow HYV Boro and Hybrid Boro crops instead of Local Boro. HYV Boro and Hybrid Boro crops also produces higher yield than local varieties. The most popular varieties which are used in the project area are: BRRI dhan 28, Hira-2, Janakraj, Sonarbangla and Alok. The Net Cropped Area (NCA) has been decreased to 7,427 hectare after interventions.

Dominant cropping pattern of the project area is Fallow-Fallow-HYV Boro covering 62% of the NCA. The total cultivated area is covered with single cropped area. So, cropping intensity of this area remained same, which is 100%. Detailed cropping pattern by land type under with project situation is presented in **Table 4.2**.

Table 4.2: Post Project Cropping Pattern in Chayer Haor

Land type	Kharif-I (March-June)	Kharif-II (July-October)	Rabi (November-February)	Area (ha)	% of NCA
Medium Low Land(F_2)	Fallow	Fallow	HYV Boro	223	3
Low Land(F_3)	Fallow	Fallow	HYV Boro	4,605	62
Low Land(F_3)	Fallow	Fallow	Hybrid Boro	1,114	15
Very Low Land(F_4)	Fallow	Fallow	HYV Boro	1,485	20
			Total	**7,427**	**100**
			Cropping intensity (%)	**100**	

Sources: CEGIS estimation based on field information, October; 2017

Impact

The Net Cultivated Area (NCA) has been decreased to 11 hectare after interventions. On the other hand, total cropped area has been remained same as NCA. The cultivated area of Local Boro has gradually been decreased and replaced by HYV Boro and Hybrid Boro crops after completion of project due to its higher yield rate and ensured early flash flood protection by project interventions. Impact on cropped area is presented in **Table 4.3**.

Table 4.3: Impact on Cropped Area in Chayer Haor

Crop name	Pre project	Post project	Impact (Post project – Pre project)
HYV Boro	-	6,313	6,313
Hybrid Boro	-	1,114	1,114
Local Boro	7,438	-	-7,438
Total	**7438**	**7,427**	**-11**

Sources: CEGIS estimation based on field information, October 2017

4.2 Crop Production

Pre Project

The estimated total annual crop production of the project area was about 22,686 tons after loss of 1,166 tons before any interventions. Detailed crop production statistics before interventions is presented in **Table 4.4**.

Table 4.4: Annual Crop Production of Chayer Haor under Pre Project Situation

Crop Name	Total Crop Area(ha)	Damage Free Condition		Damaged Condition		Annual Production (ton)	Production Loss (ton)
		Area (ha)	Yield (ton/ha)	Area (ha)	Yield (ton/ha)		
Local Boro	7,438	5,579	3.2	1,860	2.6	22,686	1,116
Total	**7,438**	**5,579**	**-**	**1,860**	**-**	**22,686**	**1,116**

Source: CEGIS estimation based on field information, October 2017

Post Project

After the implementation of the project, hydrological regime of the project area is changed. Farmers started to cultivate Hybrid/HYV Boro due to presence of submersible embankment and sluicegate, which protect their crops from early flash flood. Hence, total annual crop production is about 37,090 tons with loss of 5,838 tons after interventions. Detailed estimation of crop production after interventions is presented in **Table 4.5**.

Table 4.5: Annual Crop Production of Chayer Haor with Project Situation

Crop name	Total crop Area (ha)	Damage free condition		Damaged condition		Annual production (ton)	Production lost (ton)
		Area (ha)	Yield (ton/ha)	Area (ha)	Yield (ton/ha)		
HYV Boro	6313	4419	5.6	1894	2.8	30050	5303
Hybrid Boro	1114	947	6.8	167	3.6	7041	535
Total	**7,427**	**5,366**	**-**	**2,061**	**-**	**37,090**	**5,838**

Source: CEGIS estimation based on field information, October 2017

Impact

Additional 14,405 tons rice is being produced in post project situation. The rice production is increased due to the protection of flash flood which encourages the farmers for practicing high yielding variety instead of local variety. Detailed estimation of impact on crop production is presented in **Table 4.6**.

Table 4.6: Impact on Crop Production of Chayer Haor

Crop Name	Pre project Production (ton)	Post project Production (ton)	Impact (Pre Project–Post project)
HYV Boro	-	30,050	30,050
Hybrid Boro	-	7,041	7,041
Local Boro	22,686	-	-22,686
Total	**22,686**	**37,090**	**14,405**

Source: CEGIS estimation based on field information, October 2017

4.3 Crop Damage

Pre Project

Flash flood was the main cause of crop damage in pre-project situation. Before harvesting of Boro crop, water entered into the Haor area and damaged the crops. So, farmer of this area suffered due to the damaging of their crops in every year. Total crop damage in the project area was 1,116 tons annually. Detailed estimation of crop damage is presented in **Table 4.4**.

Post Project

Chayer Haor is now protected from early flash flood by the project interventions which basically performed well up to 2010. After that, most of the year, flood water enters into the project area before harvesting of Boro crop (early to mid-March) due to low height of submersible embankment and malfunctioning of structures. Floodwater coming from the upstream through the Mara Gang and Surma rivers enters the scheme area through embankment breaches as well as through regulators. The main khals through which floodwater enters: a) Mauti Khal, b) Khara Khal and d) Krishnapur Khal are located at the upstream part of the north-western area.

As this haor is located relatively downstream in comparison with the haor in Sunamganj, flash floods enter the haor in the 1st week of the month April. The main reasons for the flash floods are: a) more rainfall-runoff and inflow from the upstream, b) weak flood protection embankment c) silted up rivers and as a result, fast rising water level.

Every year BWDB closes the major breaches and entrances of the khal. The main reason for flooding in this Haor over the years is that the rivers have silted up and their water flowing capacities are gradually reducing. The excessive sedimentation makes rivers incapable of holding and conveying floodwater, which creates excessive pressure on earthen embankment. Moreover, plant height of hybrid/HYV is less than local varieties and growing period of most of the Hybrid/HYV varieties are higher than local varieties except BRRI dhan28. So, flood water affects the whole crop area at a time. Most vulnerable mouza's such as Krishnapur, Anandapur, Bhati Mohammadnagar, Sultanpur, Niamatpur, Sukhlain, Keruala, Haripur, Moktarpur and Shantipur are identified in this respect. Total crop damage is recorded as 5,838 tons in with project situation. Detailed estimation of crop damage in with project situation is presented in Table 4.5. The devastating flash flood in inundated the entire haor area in the first week of March, 2017 and damaged all the standing crops. It caused immense sufferings to the local populace. Some segments of the embankment were breached at that time. At present, the crest level of the embankment of Niamatpara, Anandapur and Durlavpur was found to be below the design level. As a result, flood water enters the haor through these areas within seven days which is supposed to enter after 10 to 12 days from its occurrences. As a result, flash flood causes crop damage and sufferings to the people every year.

Impact

Though, the crop damage area has been increased from 25% to 30% after interventions. However, the amount of crop damage has increased by 4,722 tons because the total production has increased significantly. The crop damage area is increasing day by day due to malfunctioning of the interventions and reduced water carrying as well as retention capacity of surrounding rivers, khals and beels. Detailed impact assessment on crop damage is presented in **Table 4.7**.

Table 4.7: Impact on Crop Damage in Chayer Haor

Crop Name	Pre Project Production Loss (Tons)	Post Project Production Loss (Tons)	Impact (Pre Project–Post Project)
HYV Boro	-	5,303	5,303
Hybrid Boro	-	535	535
Local Boro	1,116	-	-1,116
Total	1,116	**5,838**	**4,722**

Source: CEGIS estimation based on field information, October 2017

4.4 Irrigation

Pre Project

Before initiation of the project, only surface water was used for irrigating Local Boro crops. The local people normally transplanted this crop immediately after the floodwater recedes and the land is under shallow inundation. Local farmer reported that they stored water with help of bundh/dyke management and irrigated their crop with the help of flooded water in the low lying part of the Haor. They also used traditional modes like *Seuti, Don and Cone* for irrigating their crop from surrounding rivers, Beels and Khals during dry season. Prior to the implementation of the project, irrigation water was more available than the requirement of crops.

Post Project

After implementation of the project, the irrigation water demand has been increased due to cultivation of high water demanding Hybrid/HYV Boro instead of Local Boro crop. On the other hand, the availability of surface water is being reduced due to siltation of surrounding rivers, khals and beels of the project area. Therefore, the scarcity of irrigation water has been observed from early February to end of March in most of the year. In this time, Sumna, Mara Gang and Darain), khals (Mauti khal, Chayer khal, Dhora-Banga khal, Khara khal and Krishnapur khal) and beels (Mauti beel, Kabia beel, Khara beel, Ghaita beel, Atra beel, Marigang beel, Chhapta beel, Khash beel and Sisani beel). Mainly Low Lift Pumps (LLPs) is being used for lifting surface water instead of traditional mode. The Khals ((Mauti khal, Khara khal and Krishnapur khal)) dried up in December-January and Beels (Mauti beel, Kabia beel, Khara beel, Ghaita beel, Atra beel, Marigang beel, Chhapta beel, Khash beel and Sisani beel) are also dry up by bailing out of water in the month of December-January for harvesting fish.

Impact

There was deficit of irrigation water due to increase of water demand and decrease of water availability during dry season. The irrigation water demand has increased for cultivating high yielding crop variety. On the other hand, surface water irrigation availability has decreased due to siltation of rivers, khals and beels of the project area.

4.5 Use of Agro-Chemicals

Pre Project

Farmers of the project area cultivated only Local Boro in pre-project situation. They didn't apply agro-chemicals for crop cultivation. However, some farmers used inorganic fertilizer like mixed grass and rice straw in the crop field for the restoration of soil fertility.

Post Project

Generally more agro-chemicals are required for cultivating HYV /Hybrid Boro crops. So, farmers applied more agro-chemicals for Hybrid/HYV Boro crop cultivation. Total about 1,730 tons chemical fertilizers, 1.541 Kilo litre liquid and 31 tons granular/powder pesticides were used in the project area for crop cultivation per year. Detailed use of agro-chemicals under post-project situation is presented in **Table 4.8**.

Table 4.8: Use of Agro-Chemicals with Project Situation

Crop Name	Fertilizer (Kg/ha)			Total (kg/ ha)	Pesticides		Total	
	Urea	TSP	MP		Liq. (ml/ha)	Gran. (Kg/ha)	Liq. (Litre/ha)	Gran. (kg/ha)
HYV Boro	150	50	30	230	200	4	0.2	4
Hybrid Boro	160	60	30	250	250	5	0.25	5
Total	**310**	**110**	**60**	**480**	**450**	**9**	**0.45**	**9**

Source: CEGIS estimation based on field information, October 2017

Impact

Use of agro-chemical has increased largely under Post-project situation compared to pre-project situation. Additional about 1,730 tons chemical fertilizers, 1.541 Kilo litre liquid and 31 tons granular/powder pesticides are used for crop cultivation annually. Detailed impact on use of agro-chemical is presented in **Table 4.9**.

Table 4.9: Impact on Use of Agro-Chemicals in Chayer Haor

Crop name	Pre Project			Post Project			Impact		
	Total Fertilizer (ton)	Pesticides		Total Fertilizer (ton)	Pesticides		Total fertilizer (ton)	Pesticides	
		Liquid (Kilo Liter)	Gran. (ton)		Liquid (Kilo Litre)	Gran. (ton)		Liquid (Kilo Litre)	Gran. (ton)
HYV Boro	-	-	-	1,452	1.263	25.252	1,452	1.263	25.252
Hybrid Boro	-	-	-	279	0.279	5.57	279	0.279	5.57
Total	**-**	**-**	**-**	**1,730**	**1.541**	**30,822**	**1,730**	**1.541**	**30,822**

Source: CEGIS estimation based on field information, October 2017

5 Livestock Resources

Livestock and poultry, being an essential element of integrated farming system, play an important role in the economy of the Haor area. Livestock provides significant draft power for cultivation, threshing and crushing of oil seeds; cow dung as a source of manure and fuel; a ready source of funds; and meat, milk and eggs for human consumption. A large number of livestock are reared in Haor areas but constrained by flash flood causing inundation of large areas during most of the time in the year. This area is famous for duck rearing due to availability of natural feed for ducks in natural large water bodies. All of livestock species suffer much due to shortage of feed, outbreak of waterborne diseases and inadequate shelter facilities. The livestock rearer in the Haor areas do not get fair price due to poor communication as well as lack of marketing facilities.

The indicator status of livestock has been selected for assessing the impact of the project. The status of livestock population data were collected from Livestock Census (1986), Agriculture census (1996 and 2008) of BBS. The status of livestock feed and fodder, diseases, marketing facilities information were gathered from stakeholders through Focus Group Discussion (FGD) and Key Informant Interview (KII).

5.1 Status of Livestock/Poultry

Pre Project

According to livestock census 1996, the livestock and poultry population in the project area were 6,780 cattle, 530 goats, 11,350 chicken and 11,120 ducks (**Table 5.1)**. Before implementation of the project, the major feed available to ruminants was mostly crop residues (rice straw) supplemented with weeds from cultivated fields. They are to depend on naturally grown grasses in Kandas and alongside roads and embankments. Most of the year before implementation of the project, the crops were to damage by early flash flood. As a result, shortage of feed from crop residues, reduction of grazing facilities seriously affect livestock rearing. That time, the small holders were to depend on water hyacinth and other aquatic plant for their cattle. The major poultry feeds were rice bran, broken rice, kitchen wastes like rice, rice-gruel, vegetables, fish wastes etc. In addition, the duck usually scavenge in the nearby water bodies like Haor, beel, khal, river or any other low lying areas; mainly eat various types of aquatic insects, small fish, shell or snails. Galafula (Haemorragic Septicemia), Foot and Mouth Disease (FMD) etc. which were reported in project area. Major poultry diseases were Duck cholera and Fowl pox etc. The most vulnerable period was between July to November for spreading diseases to livestock and poultry populations. Mortality rate of the livestock/poultry was higher due to poor shelter condition and they lived in unhygienic condition. Marketing facilities was not in good condition and price was also low due to less demand of their products and by products. Producer consumed their products at family level and additional products were sold at local village market.

Table 5.1: Status of Livestock/Poultry in Chayer Haor

Livestock/ Poultry Category	Pre Project		Post Project		Impact
	No of Households having Livestock	Total No of Livestock	No of Households having Livestock	Total No of Livestock	Number of Livestock Population
Cattle	1,670	6,780	2500	8850	2070
Goat	220	530	120	280	-250
Chicken	2,090	11,350	1980	12160	810
Duck	1,690	11,120	1060	7300	-3820

Source: CEGIS estimation based on livestock census (1996), agriculture census (2008) and field information (October 2017)

Figure 5.1: Cattle at the Krishnapur Mouza

Figure 5.2: Duck Mohammadnagar Mouza

5.2 Livestock Scenario in Chayer Haor System

Post Project

According to agriculture census 2008, the livestock and poultry population in the project area are 8850 cattle, 280 goats, 12160 chicken and 7300 ducks (**Table 5.1**). After implementation of the project, crop is protected from early flash flood. As a result, the feed availability of livestock is increased due to increase of crop production. However, some of the year, the crops were damaged by early flash flood. In that year, the small holders were dependent on water hyacinth and other aquatic plant for their cattle. The poultry feeds are same as in pre project situation. On the other hand, more or less similar diseases are found in post project situation. The mortality rate of the livestock/poultry became negligible during the project period, due to extension works at farmers' level such as immunization and insemination program by Department of Livestock (DLS). Marketing facilities during dry season also improved due to improvement of the communication system by constructing the submersible embankments. Therefore, market prices are increased due to high demand of products and by products.

Impact

From 1996 to 2008, about 2,070 cattle and about chicken 810 have increased due to the reduction of flood vulnerability, improvement of marketing facilities and strengthening of livestock extension services. On the other hand, the goat and duck population has been decreased to 250 and 3,820 respectively. Details about impact on livestock are presented in **Table 5.1**.

6 Fisheries Resources

Chayer Haor system is bounded by two-river system (mentioned in Water Resource Section) which act as the major water sources for maintaining sustainability of fish habitat. This Haor is surrounded by a number of Haors: a) Khaliajuri FCD Polder-2 & 3 in the west, b) Bhanda Beel Scheme and Bedar Dohar Haor in the east, c) unprotected land in the north and south. The Chayer Haor is fed by a number of connecting Khals of which important ones are Kukhra Khal and Abra Khal which meet with the Old Surma River at Muradpur and Sirail Mauzas. The Haor possesses a large number of Beels of which major ones (sizes vary from 4 to 25 ha) are Mauti Beel, Chayer Beel, Ghaita Beel, Moragang Beel, Kabla Beel, Khara Beel, Khash Beel, Sissani Beel, Atra Beel, Ganuki Beel etc. According to local people, Mauti Beel, Chayer Beel, Ghaita Beel and Moragang Beel are the main fish breeding grounds of this Haor System. The field investigation revealed that the water centric interventions significantly control the hydrodynamic condition for fisheries resources of this Haor System.

6.1 Habitat Area

Pre Project

Fish habitat has been assessed from the landuse data that is extracted from the satellite image of 1989. The estimated total area of fish habitat of the Haor was about 7,929 ha where capture fishery was the sole contributor. There were some pits/ponds having no dike inundated naturally and some ponds with high dike. The ponds without dike are considered under floodplain habitat whereas the ponds with high dike had aquaculture activities. There was a Baor (Oxbow lake), given lease and functioned as a culture fishery. Floodplain shares the major part (about 94%) in the total habitat area followed by Beel, Khal, Baor and fish pond. The breakdown of functionally different fish habitats of this Haor is given in **Table 6.1**.

Post Project

Similarly, the estimated fish habitat area has been assessed from the land use data, which extracted from satellite image of 2015, is about 8,143 ha. The increment of fish habitat area by about 260 ha, which is contributed by newly created borrow pit area of about 250 ha, Khal area of about 9 ha and fish pond area of about 1 ha. On the other hand, the decrement of fish habitat area by about 46 ha, which is contributed by the loss of Beel area of about 32 ha, floodplain area of 11 ha and Baor area of about 3 ha. The habitat area loss offsets the habitat area gain and thus the resultant net gain of habitat area is about 214 ha. The increment of habitat occurs may be due to re-excavation of the internal Khal and excavation of new channels/Khals and newly created borrow pit in the Haor. The borrow pit is created for the construction of submersible embankment and cross-road. The breakdown of functionally different fish habitats of this Haor and habitat changes is given in **Table 6.1**.

Table 6.1: Breakdown of Fish Habitat Area by Habitat Type

Sl. No.	Habitat Category	Habitat Type	Area (Ha)		Impact (Ha) (Habitat Area Change)
			Pre-Project, 1989	Post-Project, 2015	
1	Capture Fishery	Khal	195	204	9
2		Perennial Beel	249	217	-32
3		Floodplain	7438	7427	-11
4		Borrow Pit	-	250	+250
		Sub-Total =	***7,882***	***8,098***	***216***
5	Culture Fishery	Fish Pond	2	3	+1
6		Baor	45	42	-3
		Sub-Total =	***47***	***45***	***-2***
		Grand Total=	**7,929**	**8,143**	**+214**

Source: Fish habitat assessment based on field findings and image based landuse data 1989 & 2015.

Impact

The net gain of fish habitat area in the Post-Project condition is about 214 ha, which is negligible (about 2.7 %) in compared to Pre-Project condition.

6.2 Habitat Condition

Pre Project

Floodplain was unregulated; timely entry of water into the Haor; silt carried by the rivers was dispersed over the Haor uniformly; river conveyance capacity was more. Local people opined that the Beels retained water in the dry season at a depth suitable for fishery. Among the Mauti Beel, Chayer Beel, Ghaita Beel and Moragang Beel had average depths ranges from about 2.5-3.5 m during dry season. Some of the Beels, such as Kabla Beel, Khara Beel, Khash Beel, Sissani Beel, Atra Beel, Ganuki Beel etc. were shallow and dried up by bailing out of water in the month of December-January for harvesting fish. There were some Beels with leasing system and the lessee control the Khal mouth to hold water for fish production during recession period and to inhibit water entry into the Haor to protect Boro paddy during the onset of monsoon.

Little better ecosystem was maintained with the exchange of pre-monsoon nutrients between river and Haor; new water breeding stimulation to the small indigenous species (SIS) of fish; higher breeding success; less natural and fishing mortality; rich biodiversity; more sustainable fish production, etc.

Post Project

Floodplain is regulated; floodwater enters into the Haor in the late pre-monsoon; silt deposited on the river bed as dispersion of silt is hindered or restricted by the submergible embankment; decreased river conveyance capacity. Local people opined that some of the Beels retained water in the dry season at a depth less suitable for fishery. Among the Beels Mauti Beel, Chayer Beel, Ghaita Beel and Moragang Beel average depths ranges from about 2-2.5 m during dry season. This is happened may be due to wash out of loose soil of agriculture land and breached embankment along with river borne sediment. Some of the Beels, such as Kabla Beel, Khara Beel, Khash Beel, Sissani Beel, Atra Beel, Ganuki Beel are shallow and dry up by bailing out of water in the month of December-January for harvesting fish.

There are some Beels with leasing system and the lessee control the Khal mouth (in some cases earthen closure made by BWDB where water regulatory structures are not functioning) to hold water for fish production during recession period and to inhibit water entry into the Haor to protect Boro paddy during the onset of monsoon.

Ecosystem is being degraded gradually but lightly as some of the water control structures are not functioning properly. Exchange of pre-monsoon nutrients between river and Haor is being hindered or restricted to some extent by the submergible embankment; delayed new water entrance into the Haor and hampering breeding stimulation to the small indigenous species (SIS) of fish; in some cases egg deposited in the fish body; lower breeding success; little higher natural and fishing mortality; slightly declining trend in fish biodiversity; less sustainable fish production, etc.

Impact

The net physical condition of habitat is negligibly degraded and corresponding provisioning services of the ecosystem including fish. However, the changes in habitat suitability condition of rivers, Khals and Beels in terms of quality occurred more due to unconventional Beel fishery, illegal fishing (use of chemical fertilizer), extensive use of agrochemicals and pesticides in paddy field, etc. rather than water centric interventions.

6.3 Fish Diversity

Pre Project

This Haor was rich in fish biodiversity containing about 110 species (**Table A-I of Appendix**) in the pre project condition as some of the Beels are perennial and retained water at higher depths mentioned above suitable for fishery. The fish diversity particularly SIS was also facilitated by the unregulated lateral migration from river to Beel and Beel to river during pre-monsoon breeding season. Thus Beel resident fishes (Particularly 'SIS' of Fish) were dominant in the Beels and floodplain. Moreover, the abundance of large-sized adult fish species (Rui- *Labeo rohita*, Catla- *Catla catla*, Ghonia- *L. gonius*, Boal- *Wallago attu, Ayre- Mystus aor,* Chital- *Notopterus chitala,* Shol- *Channa striatus, Gojar- Channa marulius,* Pabda- *Ompok pabda,* Boro Baim- *Macrognathus aculeatus,* Shar Punti- *Puntius sarana, etc.)* were also more. Furthermore, species were evenly distributed in the whole Haor system.

Post Project

Fish species diversity has the declining trend but in slow pace in the Post Intervention condition. This is happening may be due to many factors other than water control structures. The factors include habitat loss (both depth and area), water pollution, water regulatory structures, unplanned fisheries management, over exploitation of fish due to increase of fishers and modernization of fishing technology, indiscriminate fishing e.g. use of harmful fishing appliances, catching of post larvae and brood fish, complete dewatering of leased water bodies (less than 5 acres) for fishing, etc. In consequence of the above phenomena, following fish species become locally unavailable (for last 5-10 years) or have become rare includes Pabda, Boro Baim, Shar Puti, Chital, Ayr, Boro Chingri (*Macrobrachium rosenbergii*), Nanid (*Labeo nandina*), Rui, etc.

Impact

Comparing pre and post project condition, it can be concluded that changes in fish species diversity and composition are not comprehensible in response to Project Intervention. Whatever changes in species diversity and composition between two phases are observed may be posed due to other anthropogenic factors mentioned above.

6.4 Fish Migration

Pre Project

Previously the Haor was hydrologically linked with the Bedar Dohar Haor and Kalikota Haor. For this reason, the abundance of large fishes like Rui, Catla, Ayer, Chital, etc. were more. Local fishers stated that the lateral fish migration was open through the natural connectivity during pre-monsoon. Furthermore, most of the fries of riverine fishes enter the Beels and floodplain along with flood water. However, successful lateral migration of different fishes, e.g. riverine carps, catfishes, etc. at their certain stages of lifecycle for food and residence is happening due to sufficient depths of the Beels.

Post Project

Pre-monsoon (15 April – 15 May) spawning/breeding migration of riverine and Beel residence SIS fishes is mostly impeded through different connecting Khals due to water regulatory structures. Besides, riverine fishes migrate laterally to the Beels by overtopping or breaching of the existing embankment of the Haor during flooding months of Jaisthya-Ashar (15 May–30June).

Pre-monsoon (15 April – 15 May) spawning/breeding migration of riverine (mainly the Surma River) and Beel residence fishes through different connecting Khal is mostly impeded due to full flood embankment along the Surma River and water regulatory structures. Besides, riverine fishes migrate laterally to the Beels by overtopping or through breaching points of the existing embankment during flooding months of Jaisthya-Ashar (15 May–30 June).

Impact

Comparing pre and post conditions, it can be concluded that migration of SIS is impeded during the pre-monsoon in Post-Project condition and comprehensible impact has not been observed on fish migration in response to submersible embankment.

6.5 Fish Production Assessment

Pre Project

The estimated total fish production was 764 metric ton (MT) in 1,989 where floodplain shared the most about 78% followed by Beel, Khal, Baor and fish pond as presented in **Table 6.2**.

Post Project

The estimated total fish production is about 3,341 metric ton (MT) in 2015 where Floodplain shared the most about 78% followed by Borrow pit, Beel, Khal, Baor and fish pond as presented in **Table 6.2**. In the production assessment, the productivity of the corresponding year has been used.

Impact

Net increase in fish production in Post-Project condition is about 2,578 metric ton. As a whole, fish production has been increased by about 338%, whereas the floodplain production by about 337%, Beel by about 110%, Khal by about 52%, Baor by about 409% and fish pond by about 700% (**Table 6.2**). Such huge increment in productivity may be caused due to adoption of fisheries management like Beel fishery, Beel nursery, increasing fishing activities, fishing commercialization, stocking of culture fish species in Beel fishery, etc. Moreover, the newly created habitats like borrow pit, fish pond have added 375 metric ton of fish respectively. The breakdown of fish productions is presented in the following **Table 6.2** by functional unit of fish habitats.

Table 6.2: Breakdown of Fish Production by Functional Habitat

Sl. No.	Habitat Category	Habitat Type	Production (MT)		Impact (MT) (Production Change)
			Pre-Project, 1989	Post-Project, 2015	
1	Capture Fishery	Khal	45	68	+23
2		Perennial Beel	112	234	+123
3		Floodplain	595	2600	+2005
4		Borrow Pit	-	375	+375
		Sub-Total =	***752***	***3277***	***+2525***
5	Culture Fishery	Fish Pond	1	8	+7
6		Baor	11	56	+45
		Sub-Total =	***12***	***64***	***+52***
		Grand Total=	**764**	**3341**	**+2577**

Source: Source: Fish production assessment based on field findings and FRSS data, 1989 & 2015.

6.6 Fishing Appliances

Pre Project

Different types of fishing appliances are used to catch fishes. The mostly used fishing appliances are: gill net, Ghurni Jal/Ber Jal, push net, Khoira Jal, hook, Gui (one type of trap used to catch small fishes), Chhip, etc. Furthermore, illegal fishing practice was reported in the leased Beel. Dried up the whole Beel for harvesting benthic fish species may be considered as a good example of illegal fishing. However, this type of fishing depends on the leasing rotation system.

Post Project

Leaseholders (LHs) generally use Katha as fish aggregating device (FAD) for fish. LHs usually harvest fish annually. However, another type of fishing pressure has been increased day by day around the water control structures. The local fishers (particularly part-time fishers) create barrier at the mouth of water control structures by net for catching fish. They also use Kona Jal (very small mesh size net) for catching fry to brood fish. Local people reported that usage of Kona Jal is increasing day by day. This fishing pressure becomes more prominent during recession of floodplain water in the post-monsoon season.

Impact

The scheme is almost fully functional and possesses water control structures. For this reason, some deviation in fishing activities is found in response to Project intervention. Fishing is done at each of the water control structures which were absent in the pre project condition. On the other hand, fishing pressure is also increased with the increasing of fish demand and fish supply chain for both the national and global fish market.

6.7 Fishers Livelihood

Pre Project

Field findings reveal that about 20% of the Haor population was engaged in fishing and activities involved in fish supply chain for carrying out their livelihoods. Out of which about 10% were commercial fishers and the rest of them were subsistence level fishers. Commercial fishers spent annually about 200 days (8-10 hrs/day) in fishing.

Post Project

Presently about 50% of Haor population are engaged in fishing activities. The number of fishers are increasing day by day due to demand of Haor fishes as well as increasing of market price. It may be mentioned here that about 70% households of Bahara union of Chayer Haor are involved in fishing. Because land area of this union is comparatively low and most of the perennial Beels are located here. The commercial and subsistence level fishers spend annually about 290 days (10-15 hrs/day) and 180 days (3-4) hrs/day) respectively in fishing. They mainly catch fish in the open water area in and around the Haor for carrying out their livelihoods.

Impact

It can be concluded that the number of part-time and subsistence fishers are increased in response to the Project Interventions.

6.8 Fisheries Management

Pre Project

Beel fisheries with leasing system were the prominent fisheries management as reported from the local people. All Beels were harvested in the months of February and March. Beel fishery was more sustainable. However, there was no community based fisheries management in this Haor.

Post Project

Beel fisheries with leasing system are also the prominent fisheries management in the With Intervention condition. All leased Beels are harvested annually. Seasonal Beel is used to dry up for catching benthic fish species. However, this type of fishing depends on the leasing rotation system of the Government. Beel fishery is becoming less sustainable. There is a number of fisheries associations is a community based fisheries management in this Haor. There is no enforcement for limiting or controlling indiscriminate fishing at the water control structures.

Impact

Rotation length of time for fishing in most of the leased Beels is one-year rotation except Mauti Beel, which is one-year to three-year rotation in the with Intervention condition. Such over exploitation in conjunction with indiscriminate fishing at the water control structures is being happened mostly due to earn more money and driving fishery ecosystem into fragile resources.

7 Ecosystem

Chayer Haor is located in four upazilas namely Sulla, Dirai, Khaliajuri and Itna. It occupies terrestrial as well as aquatic ecosystems. Local biodiversity and their species density and population vary in different parts of this project area according to land types and land use. Terrestrial ecosystem belongs to different homesteads, kanda and roadside vegetation of the scattered settlement and their associated submergible roads. The remaining flora is aquatic life-forms. Similarly, a diversified fauna group along with aquatic species also occurs in this haor ecosystem. Overall changes of ecosystem pattern and their diversity, coverage, habitat condition are described in the following sections.

7.1 Terrestrial Flora

Pre Project

Before intervention taken place, the study area was comprised of different terrestrial species and observed mostly in upland portion as well as homesteads, ridge, roadside area, cropfield etc. Most of the households were vegetated by local cultivated plants and a small portion of the coverage was occupied by wild shrubs and herbs. Presence of water resistant tree like Karoch (*Pongamia pinnala*), Pitali (*Trewia nudiflora*), Baroon (*Crataeva nurvala*), Hizol (*Pongamia pinnata*) were remarkably found near watersides as well as margins of settlements at the north-east portion of the Chayer haor. Common cultivated plants were Silkoroi (*Albizia procera*), Kathal (*Artocarpus heterophyllus*), Aam (*Mangifera indica*), Narikel (*Cocos nucifera*), Mahogoni (*Swietenia mahagoni*), Raintree (*Samanea saman*), Baroi (*Zizyphus mauritiana*), Shimul (*Bombex ceiba*), Jum (*Syzygium cumini*) etc. Raintree, Narikel, Silkoroi occupied the top canopy. Other trees, shrubs and herbs those occupied lower canopies such as patipata, dolkolmi, Makhna, jagotmadan, bonjal were common. Most of the tree species except wetland trees present on homestead platforms were sensitive to water. Homestead vegetation at the east portion of Krisnapur, Kallanpur, Kutubpur, shibpur, Shyampur etc. villages were under threats due to wave action in monsoon time. Except cultivated varieties, major weed species growing with the crop in this area were *Euphorbia hirta, Rorippa indica, Cynodon dactylon, Marsilea quadrifolia, Heliotropium indicum, Cyperus sp*, *Croton bonplandianum, Chenopodium sp,* etc. Different types of marginal trees like Panimorich, Biiskatali, Nol, Khagra etc. were dominant in inner portion of the canal where as bermuda grass, cyperus, cogon grass, justiceae and various types of grasses were found on upper portion of the canal dykes. Major species were cultivated along the road side of project area were Sirish, Sisso, Pitali, Jarul, Mahogoni, Sil koroi etc.

Post Project

At the present scenario, settlement area and new settlement (Locally called Noyahati) have been rapidly expanded throughout the project area especially in the east and west portion of the Chayer haor. According to local people, submersible embankment is working as a safeguard and protects internal vegetation from wave action in monsoon period, consequently terrestrial vegetation coverage and their density have enriched in homestead platforms comparing the pre intervention period. But planted tree species are mostly exotic e.g. Akashmoni (*Acacia moniliformis*), Sisso (*Dalbergia sissoo*), Manjium (*Acacia mangium*) etc. During field survey it was evident that, almost similar type of timber yielding trees exists all over the project area. Upland vegetation inside the project area has been mostly cultivated of timber and fruit yielding varieties. Mango, Jackfruit and banana have found most popular fruit yielding tree among others. Cropfield ecosystem consist least diversity of floral communities and provide wide area of grazing and feeding habitats for different wildlife.

Impact

On the basis of perceptions gathered from the sample respondent and from field observation the change in the terrestrial flora has no significant effect from the interventions. The net settlement and crop field vegetation area has been increased in mainly east and west portion of the Chayer Haor. The changes in the floral diversity and tree coverage of the area happened naturally and it has no direct link with the intervention activities. Overall terrestrial floral diversity and coverage have been changed but insignificant. Indicator species and their ecological status are presented below (**Table 7.1**).

Figure 7.1: Terrestrial Floral Composition Inside the Chayer Haor Area

Table 7.1: Changes of status of indicator species

Indicator	Location	Pre Project	Post Project	Cause of status change	Type of Intervention that caused the change (Yes/No)
Exotic species	Settlements, Roads, Ridge	Low dense	Moderate dense	Increase plantation program	No
Native species	Settlements, Crop field	Moderate	Low	Agricultural expansion, Exotic tree plantation	No
Agricultural weeds	Crop field	Low	Moderate	Change of cultivation pattern	No

7.2 Terrestrial Fauna

Pre Project

Diversity of terrestrial fauna is one of the most important ecological indicators to evaluate the quality of habitats. Before intervention period, natural habitat with many jungles and bushy lands were common in upland (Kandas) and medium low land areas of this haor. This land was contented habitat for native and migratory birds, mammals, reptiles, amphibians and other wild animals. Among the terrestrial mammals, common mammalian species in the project area was fishing cat *(Falis viverrina)*, Jungle cat *(Falis chaus)*, Bengal fox *(Vulp bengalensis)*, Common mongoose *(Herpestes edwardsi),* Common House rat (*Rattus rattus*), Shrew (*Suncus murinus*) etc. The population of snake was healthy as they have better shelter in this vast open landscape. Common bird of prey species was found in the project area were Black Drongo (*Dicrurus macrocercus*), Crested Serpent Eagle (*Spilornis cheela*), Brahminy Kite (*Heliastur indus*), Brown Fish Owl (*Ketupa zeylonensis*), Common Myna (*Acridotheres tristis*), Asian Pied Starling (*Sturnus contra*), Red Vented Bulbul (*Pycnonotuscafer*), Oriental Magpie Robin (Copsychus saularis), Spotted Dove (Streptopelia chinensis), Blue Rock Pigeon (Columba livia), Asian Koel (Eudynamys scolopacea), Coppersmith Barbet (Megalaima haemacephala), Jungle Babbler, Black Hooded oriole (Oriolus xanthornus), Common Hoopoe (*Upupa epops*). These were found to be more common as they always try to live near human settlements of the haor area.

Post Project

Species richness of terrestrial local avifauna has been concentrated in settlements and birds occupy higher number of species than other classes. At this time, habitats of birds, mammals, amphibians and reptiles inside the project area have been gradually being reduced due to various reasons including depletion of natural vegetation, agricultural expansion, change in natural vegetation pattern, use of pesticides and insecticides, plantation of exotic trees and other several anthropogenic activities. So, some native birds (e.g. Mayna, Dove, Starling, Bulbul, Drongo etc.), small mammals (e.g. jackal, mongoose, shrew) have been successfully adapted and expected to increase in this situation due to change of vegetation coverage and agricultural expansion. Exotic large trees have been good shelter for raptor bird. Population of snakes, lizards, skinks has been lowered in number due to hunting and killing by local people and depletion of natural habitat area. Population of migratory birds has been rich in eastern part than the other part of haor area. In the eastern side of this haor, tree plantation program is becoming popular among the locals especially swamp trees (such as Karoch, Hizal and Pitali) which is providing different ecosystem services.

Impact

Intervention has not any strong relation with the change of the status of terrestrial fauna rather the changes occurred naturally over time. For different anthropogenic activities like agricultural expansion, planting exotic and swamp trees and other human interference is responsible for the changes. Thus, intervention is has no direct impact in this regard.

7.3 Aquatic Flora

Pre Project

Compositions of aquatic floral species vary according to wetland depth and duration of inundation in the haor area. Before intervention taken place, the following types of vegetation found in aquatic habitat were submerged, free floating, rooted floating, Sedges and meadows plants. Numerous canals, beels were abounded with free floating and rooted floating hydrophytes. Submerged plants were prevalent in the project area, both in perennial and seasonal wetlands. These plants start growing with the rise of water level and persist as long as water is present. *Hydrilla verticillata* were most common in this vegetation type. Free floating plants were also common throughout the project area. *Eichhornia crassipes* and *Jussia repens* was the most dominant species followed by *Salvinia, Azolla, Pistia* and *Lemna*. Rooted floating plants make one of the most dominant plant types in the project wetland areas. At the species level *Nymphaea nouchali*, *Nymphaea stellata* etc. were most common aquatic flora. However their abundance was only in perennial and deeply flooded seasonal wetland. Sedges and meadows had formed an ecotone type consisting of amphibian plants. This type has the highest species diversity and was one of the most important wetland plant communities in the project area. At the species level *Enhydra fluctuans*, *Ipomoea aquatica* and *Ipomoes fistulosa* were common in seasonal wetlands.

Post Project

After the intervention taken place, aquatic floral species composition has been changed throughout the haor basin area due to depletion of wetland areas, surrounding river (Surma, Darain, and Moragang) siltation at project periphery, agricultural extension, uses of chemical fertilizer, over extraction of economic plants (Sapla, Padma, Singara etc.) and other anthropogenic activities. At northern portion, drainage facilities has been poor and responsible for creating a water logged situation at Bhati mohammednager, Suklain, Sultanpur village area under Bahara and Atgaon union. Water logged area has been adversely impacted on vegetation. Plant succession rate has hampered. This situation played detrimental role on local aquatic biodiversity though another portion of aquatic floral diversity and their habitat condition are still high and healthy.

Impact

Deterioration and squeeze of aquatic habitat and their floral diversity area has been gradually removed at northern part. Intervention activities are not directly responsible in this regard.

Figure 7.2: Aquatic Floral Diversity in the Project Area

7.4 Aquatic Fauna

Pre Project

The hydrological cycle and the presence of perennial and seasonal wetland provides a diversified habitat for all biota inside the haor area. In the dry period, most of the wetlands except beels in these areas remained completely or partially dry. Among amphibians, Common Toad (*Duttaphrynusmelanostictus*), Skipper frog (*Euphlyctis cyanophlyctis*), Cricket Frog (*Fejervarya sp.*) were common and found in most wetland habitat (e.g. ponds, canals and ditches) and has been the most successful in adapting to the habitat. Common Smooth Water Snake (Pyna sap), Checkered Keelback (Dhora shap), Common Skink (Anjan) was pretty common. Common wetlands bird species available in the project area were Indian Pond Heron, Little Egret, Common Kingfisher, Little Cormorant, Common moorhen etc. Migratory birds were quite common in haor area. This bird were generally take temporary shelters and flock in reed land and in numerous beel areas, paddy fields, water bodies, rivers, marshy lands and even in the local ponds. Common migratory bird of species in the project area were Chhota Sarali, Bara Sarali, Nilshir, Balihansh, Bhulihansh, Snake bird, Pintail Duck, Chokha-chokhi etc.

Post Project

It was clear after field visit that, considering the before project scenario the number and diversity of aquatic fauna has decreased over time. The mammals, birds, amphibians and reptiles population gradually dropped for different factors. As per the respondents, now migratory bird species are visiting only few beels namely Chapra beel, Mauti beel, Ghaita beel, and Chayma beel of the total haor area and the resident aquatic birds are not seen often like before. Current status of bullfrog, turtle decreases over time due to hunting and death from fishing nets. Interestingly, Eurasian Otter recently have seen by some sample respondents in Bisnupur, Shyampur, Muradpur, Krisnapur village's area from Northern to Eastern and Southern to eastern part of haor area.

Impact

Habitat condition and their diversity have been changed at southern portions due to several anthropogenic activities. Faunal habitat condition is favorable at mid and eastern portion than the others areas. Intervention activities are not directly responsible in this regard.

7.5 Swamp Forest and Reeds

Pre Project

Before project intervention, there was no swamp forest in the Chayer Haor area, but presence of wetland tree such as Karoch (Pongamia pinnala), Pitali (Trewia nudiflora), Baroon (Crataeva nurvala), Hizol (Pongamia pinnata), Bhuri (Trewia nudiflora) etc. were found at agricultural land, settlement ridge, along the road side, canal dykes, inside the baor and beel area. Reedland vegetation was mostly observed in eastern portion of the haor area. Major species were Nol (Phragmites karka), Ikor (Sclerostachya), Khagra (Xanthium indicum), Bet (Calamus tenuis), Binna (Vetiveria spp.), Chan (Imperata cylindrical), Patipata (Schumanianthus dichotoma), Kakdumur (Ficus hispida) etc. Among the tall grasses were also quite common all over at the canal dukes and settlement ridge, grazing land inside the Chayer Haor area.

Post Project

Reeds coverage area has been reduced due to wetland degradation, land converted to crop field, over harvesting of economic plants and other several anthropogenic activities. Eastern part of the Kutubpur, Kallanpur, Krisnapur, Shampur villages have enriched of reeds.

Impact

Reed land vegetation is now under threats throughout the project area. So their coverage and density are low except eastern portion within the project area. Interventions are not responsible in this regards

Figure 7.3: Aforestation Program at Krisnapur Village (Started Date 1998)

7.6 Ecosystem Goods and Services

Pre Project

Homestead and cropland vegetation have a major contribution for meeting food, fodder, medicine, fuel and other household requirements to the local people. Homestead vegetation has also major contribution for timber and fuel wood supply. Utilization of wetland plant products was high in the project area before intervention taken place. The wetland plant products and services include: animal foods (Kachuripana, Khar etc.), other foods (use as vegetables), fodder and forage, fuel (Dolkolmi), medicine and thatching (Binna grass, Chan). Fishes were the staple protein provider of the local people that comes from wetlands like haor, beels, khals and homesteads ponds.

Post Project

Ecosystem goods and services are diversified within the Chayer Haor area. Utilization of wetland plant products has been reduced gradually over time. Binna grass is now low density in project area because of over harvesting for household purpose. Medicinal plants have been destroyed due to over extraction and agricultural expansion throughout the area. Though each year new succession of herbs and shrubs on settlement ridge increasing overall vegetation coverage that supports feeding and grazing habitats of many fauna like bee-eater, flycatcher, skink, frogs etc.

Impact

Degradation of the conditions of swamp forest and reed beds has lead to several impacts on resource use and livelihood of the local people. Swamp forest and reeds bed used to act as a good shelter and feeding ground for aquatic faunas, birds including fish. Thus degrading swamp forests for anthropogenic causes leading indirect effect on fish dependent bird and other wildlife resulting food crisis. Intervention may suspect to the siltation in the haor area but has no direct relation with the effect of swamp forest and reed land regeneration. Conversion of reedland for agricultural expansion is only considered indirect impact regarding this issue.

8 Socio-economic Conditions

8.1 Introduction

Haors with their unique hydro-ecological characteristics are large bowl-shaped flood plain depressions located in the north-eastern region of Bangladesh. The haor system provides a wide range of economic and non-economic benefits to the local people as well as to other people of Bangladesh. These include benefits in terms of rice production, fish production, cattle and buffalo rearing, duck rearing, collection of reeds and grasses, collection of aquatic and other plants. This study was conducted at Chayer Haor under the Sullah and Khaliajuri upazila. The socio–economic scenario was explored in this section to understand both before and after project people's condition using both primary and secondary data in relation to the objectives of the study.

8.2 Location and Population

This study has been conducted in Chayer Haor which is located at the Sullah upazila in Sunamganj and Khaliajuri upazila in Netrokota district. There are thirty (30) mouzas under the Atgaon and Bahara union in Sulla upazilla and nine (9) Mouzas under Krishnapur union in Khaliajuri upazila. Following Table 8.1 shows the union wise population of this study area, based on Bangladesh population and housing census 1991, 2011 and projected population in 2017.

The population and housing census data 1991 shows the number of population before intervention. The population and housing census data 2011 and projected population data in 2017 depicted the demographic condition of the study area after project intervention.

Table 8.1: Union Wise Population of the Study Area

District Name	Upazila Name	Union Name	Total Population in 1991	Total Population in 2011	Projected Total Population in 2017
Sunamganj	Sullah	Atgaon Union	26057	31466	79675
		Bahara Union	20255	27515	
Netrokona	Khaliajuri	Krishnapur Union	11178	14448	
Total Population			**57490**	**73429**	

Source: Bangladesh Population and Housing Census 1991 & 2011

8.3 Livelihood Status

Pre Project

Agriculture was the prime source of livelihood for the majority of population. They are focused predominantly on agricultural labour associated with the single annual rice cropping cycle. Production of crops yielded them their food and cash money. The livestock, forestry and fisheries were the secondary sources of income. In addition, few people were engaged with other sources of income like non-agricultural labor, business and employment.

Post Project

The primary livelihood (agriculture) remaining almost the same as before, its environment has improved with higher yields and less damage to crops. According to the local people, most of the people (about 80%) are engaged in agriculture. Fishing, which was traditionally second major livelihood in the haor region, has declined in recent years due to leasing arrangements which are often controlled by local elites resulting in highly restricted access to open water fisheries by the poor. Also the livestock husbandry as a livelihood activity in the haor region has also declined due to a combination of factors including the conversion of grazing land to paddy cultivation, increased population density and increased disease burden on animals due to increased temperatures associated with climate change. Besides, Livelihood opportunity for wage labour has increased in agriculture. Overfishing from the haor and siltation of riverbeds have recently caused reduction of fish resource, thereby causing loss of livelihood opportunity for the poor. Nevertheless, poor women and their households are involved in a variety of income generating activities although the vast majority of these are traditional to the Haor. Women have increased their skills in vegetable growing and livestock.

Impact

Agriculture is the main sources of income so far and the agricultural production is increasing in Chayer Haor area (see section on Agriculture below, for details). Income opportunity based on fishing has declined and only some people from fishing community got access to do work as seasonal labor in this particular area. Due to leasing arrangements, which are often controlled by local elites, result in highly restricted access to open water fisheries by the poor.

8.4 Accessibility in Education and Health

Pre Project

The health and education services for the people of Chayer Haor were not accessible to all. During the rainy season, primary education was frequently disrupted during floods almost every year. People used boat to go to schools and health clinics while walking was the only choice when boat did not ply. Schools remained closed for 70 days on average every year due to flooding. The school houses were used as flood shelter for the affected people. On the other hand, students living in distant areas usually used to drop their classes due to unsafe communication during monsoon. On the other hand, the flood- induced poverty increased the number of drop-out students in this haor.

Post Project

Health and educational institutions have increased with time and people, especially school going children, have become enthusiastic to go to schools run under different Govt. and NGOs programs. Besides, when the submergible embankments were constructed, local people, school going children, pedestrian, women and other people have been using it as road especially in the dry season. Presently, when some of the locations of the embankments are damaged, people’s way to reach to the schools and health institutions are reported to be hampered for a certain period. But in wet season, deferent types of boats are the main sources of transportation for going to school and health center.

Impact

Impact of the construction of Chayer Haor on literacy and health has been marginal: except for inundation of the embankment for 2 months a year. The submergible embankments have been used as road to access schools and clinics for the remaining period round the year. Patients on emergency can be taken to clinics by using local vans or rickshaws along the embankment in dry season when alternative roads are not existing. The indirect benefit to education and health services is the increased affordability of small and medium farm households to avail those services with their increased agricultural and ancillary income due to protected crops and other resources from damage as an effect of flood control and drainage infrastructures.

8.5 Land Price

Pre Project

Before intervention, the land price of this haor region was minimal and people were not interested to buy land due to regular flash flood and crop damage. It is reported by local people that the price of agricultural land was BDT 6000 to BDT 7000 per Keyar[1] and BDT 10,000 to BDT 12,000 for homestead land before project.

Post Project

With the project-induced change and autonomous development in the whole haor region this situation has changed and the land price has increased with the period of time. After the project intervention, the land price has increased due to the increased productivity of land. Though exogenous factors like macroeconomic development and inflation have contributed to raise the land price, people's interest to buy those land is acknowledged to be one of the reasons of rise in land price.

Impact

Due to flash flood protection and enabling environment for HYV rice culture, value of land has appreciated by more than thrice the pre-project price. Presently, the price of agricultural land per Keyar (30 decimals) is around BDT 1.5 lakh to BDT 2 lakh whereas the price of homestead lands learnt as BDT 2 lakh to BDT 3.0 lakh per keyar.

8.6 Agriculture Based Income

Pre Project

Livelihood opportunities for households in Chayer Haor project were limited and highly seasonal, as they were focused predominantly on rice based farming labour associated with the single annual rice cropping cycle. Fishing was traditionally an important occupation for the people of haor region. The incidences of livestock husbandry as a livelihood activity in the haor region were also prominent as their tertiary source of income before the intervention.

Post Project

After project intervention, the income opportunity based on agriculture has increased and people have got favorable agronomic environment to grow HYV paddy and recruit local labor

[1] 1 Keyar = 30 decimals

generating extra income opportunities for the wage earning households. People who have more land can grow more crop after the project.

Following Table 8.2 shows the agricultural income based on land ownership stratum. Based on current production rate (per decimal), agricultural income has been calculated and presented in this table. According to this table, the category of landless people naturally did not get opportunity in both before and after project situation. Marginal farmer (farmers who own 0.004 – 0.198 ha land) depend on sharecropping of land owned by the others. Marginal farmer category shows a 5% rise in population (25% before and 30% after project). The reason is learnt to be a proliferation in this category entering from absentee medium farmer group who sell out land to owners of upper categories due to high cost of production they cannot afford. Even they become landless when they sell all their land for sustenance. At the same time the percentage of medium and large farmers also decrease about 5% (before 15% and after 10%). There are some autonomous factors like population growth and distribution of property through inheritance playing the major role in the changes in land ownership composition. Hence is the increase in absolute landless group by 5%.

Table 8.2: Land Ownership and Income

Land Ownership Stratum	Households (%)		Income (agriculture base)	
	Before Project	After Project	Before Project (BDT)	After Project (BDT)
Absolute Landless(0 ha)	**20**	**25**	-	-
Functional Landless and Marginal farmer (0.004 – 0.198 ha)	**25**	**30**	5402	8846
Small farmer (0.202 - 1.008 ha)	**25**	**25**	32306	52896
Medium farmer (1.012 – 3.032 ha)	**15**	**10**	107939	176734
Large farmer (3.036 ha and above ha)	**15**	**10**	162071	265366

Source: Field data, 2017 through FGD, KII, and Informal Interview

The increased income of different land-size group's households due to project interventions is presented below. Standard five land size categories have been used and net increase in yield of rice crop due to improved cultural environment is shown.

Table 8.3: Increased Yield and Income for Farm Households by Land Holdings

Land Ownership Stratum	Average size of land (ha.)	Increased Yield/ha (ton)	Total Increased Production (ton)	Price/ ton (Tk)	Total Additional Income for the Average Size(Tk)
Absolute Landless(0 ha)	0	0	0	0	0
Functional Landless and Marginal farmer (0.004 – 0.198 ha)	0.101	2.4	0.2	21400	5187
Small farmer (0.202 - 1.008 ha)	0.605	2.4	1.5	21400	31073
Medium farmer (1.012 – 3.032 ha)	2.022	2.4	4.9	21400	103850
Large farmer (3.036 ha and above ha)	6.518	2.4	15.6	21400	334764

NB: The ceiling size of the large farmer assumed 10 ha. Average land owning size is the median value of the class. Increase in yield/ha is a difference between yield of Local and HYV Boro. Increase in yield/ha is a difference between yield of Local and HYV Boro. Price of Boro paddy /ton is Tk 21400 as per govt. procurement rate

Source: Field data, 2017 through FGD, KII, and Informal Interview

Impact

Regular flooding and water logging condition, especially during the March-April (time of *Chaitra* and *Baishakh,* Bengali Month), used to damage agricultural production very often before the project and therefore, the income opportunity of agricultural households declined. The opportunities for agricultural labor were also limited during the time of before project condition for the same reason.

After project intervention, people got enabling environment to grow more paddy and recruit local labor generating extra income opportunities. So the income opportunity based on agriculture has increased with project. People who have more land can grow more production during the project period.

8.7 Income of Agricultural Wage Labor

Pre Project

Before project, the total agricultural land was 7438 ha and total annual paddy production was 22,686 ton in the study area. It was found that net demand for labor per ha was about 120 and most of the labor came from outside than the locality.

Pre Project

After intervention, the total crop area is 7,427 and its total annual paddy production is 37,090 ton. As a result, the total crop production has increased. Livelihood opportunity for wage labour has also increased in agriculture compared to the situation before. The demand for agricultural labour is about 165 (for HYV Aman, Hybrid Boro, and HYV Boro) per ha, causing 45 man days' increase per ha due to project. The wage income of local labour households has increased with project. In this way, BDT 359838000 agricultural wage labor income increased with the period of after project.

Impact

Regular flooding and water logging condition especially during the time of *Chaitra* and *Baishakh* (Bengali Month) inflicted damage to agricultural production before the project and, therefore, the income opportunity of agricultural households declined. The opportunities for agricultural labor were also limited during the time of before project condition.

After project intervention, people got enabling environment to grow more paddy and recruit local labor generating extra income opportunities. So the income opportunity based on agriculture has increased with project. People who have more land can grow more production during the project period.

8.8 Transport and Communication

Pre Project

Transport and communication is very fragile in haor areas. Waterway is the main route of communication of the people in Haor areas. Boat and trawler are the main modes of transportation. Haor areas remain under water for 4-6 months during the pre-monsoon and monsoon and post monsoon season. The roads get submerged during this period making it impossible to travel from one place to other without using boats. Before intervention, there was no defined road network inside the haor except the boundary (*Ayle*) of crop land. In the dry season, people use bicycle or local other indigenous vehicles for transportation. Sometimes people from other haor areas come to this haor through main river route and local channels. Big sized launches, ships, barges usually run in the river during monsoon.

Post Project

After the period of project intervention, people started to use those submergible road or embankment as road to go to school, connecting roads, bazaar and health center etc. Though those embankments were not suitable for driving automobiles but people got opportunity to ply auto rickshaws and bike during the dry season. But in wet season, boat is the main sources of transport and communication in this region. But people have to wait for long time to travel to different places. They can hardly travel to the urban center twice or thrice a day. Due to the unavailability of the boats and trawlers, people with urgent health needs cannot come to the hospitals/ health complexes at the urban centers. These poor transport and communication problems many a people lose their lives in haor areas. Due to the lack of transportation, the incidence of death of children and pregnant women is higher and is quite unfortunate.

Figure 8.1: Embankment Road in the Study Area

Figure 8.2: Submergible Road in the Study Area

Impact

The BWDB's submersible and compartmental embankments are playing main role in communication across the haor. This has expedited the transportation of goods and harvests too far off places at low cost. Moreover, accessing schools and clinics has become relatively easier for children and patients along the embankment at least when flood water recedes.

8.9 Institution and Governance

Pre Project

Bangladesh Water Development Board (BWDB) was liable for physical implementation of water sector projects in haor region. Of late, Department of Haor and Wetland Development has been created. As apex institutions, these two have been administering all plans and projects in haor region

Before the project intervention, local government organization like Union Parishad or Thana Parishad existed with mandate to look after haor water resources. Inundation by flood waters was almost a regular phenomenon in haor area. Leasing of Jalmahals has been the prime activity of those institutions for raising revenue of the government. It was only after BWDB was created that the issues of water development came in.

Post Project

After the project implementation, Water Development Board started to develop and monitor the project activities in Chayer haor. Their role for operation and maintenance and repairs was regular with the completion of submergible embankments. Despite improvements in communications and access to basic services of healthcare and education in recent years, local government institutions in the haor region are still considered as being very weak in terms of their effectiveness and accountability, and participation in local development processes is very low. Presently, it has been found from the consultation with primary stakeholders that, those institution are visible only during the period of damage and to monitor the physical condition of those embankments after the flooding condition. According to the local people, the officials from this institution do not consult with the local people for lessening the damage of those submergible embankments.

Impact

The presence of BWDB and the Water Management group has some institutional impact on the beneficiaries of the haor project. Overseeing the operation and maintenance of the infrastructures is the main function of those institutions. But the condition of physical infrastructures of the haor is reported to be running below the desired level.

9 Summary of Impacts

9.1 Summary of Impacts

Indicators	Pre Project	Post Project	Impact
Water Resources			
Flooding situation	Before implementation of the project, the haor was inundated frequently by flash flood during middle of March to early in April.	After implementation of submersible embankment and closures by BWDB in 1993, entrance of flash flood into haor got delayed by 10 to 12 days	Interventions of the haor have reduced the risk of entrance of flood water and saved the crops from damage.
Drainage condition	Most of the flood water smoothly drained out to the peripheral rivers such as Darain, Surma and Mora-Gang, through the drainage khals and some water stored in the low-lying beels.	The drainage of the haor has deteriorated a little bit. It got delayed by 5 to 7 days than the pre-project condition.	The drainage of water of the area has become slower than before but not impacted largely. The drainage of the western side of the haor has deteriorated in the downstream side as the sluice gate is not working properly.
Sedimentation and siltation	The sediment carried by the flash flood got deposited both in the rivers and haor area. Hence, sedimentation inside the haor and in the peripheral rivers and Khals was not that much problem before implementation of the interventions.	Sedimentation has taken place in the river and khals over the years. As a result the bed level of the peripheral rivers and khals has risen and conveyance capacity has also been reduced.	Sedimentation has increased in the peripheral rivers as well as connecting khals and beel bed compared to pre-project condition.
Navigation	There was navigational connectivity between the haor and the nearby rivers throughout the year. During monsoon, it was the major mode of communication of the local people.	There are no changes in navigational connectivity of the haor and the peripheral river during monsoon and limited navigation also takes place through the breached points and public cuts upto February/March before repair. Moreover, navigation in the peripheral river has not been affected. However, navigational connectivity does not persist during February/March–April/May due to repair of submersible embankment. However,	The navigational connectivity has not been affected in monsoon but it does not operate during February/March–April/May due to repair of submersible embankment. Moreover, navigation in the peripheral river has not been affected.

Indicators	Pre Project	Post Project	Impact
		communication system has improved tremendously in dry season, due to construction of submergible embankments.	
Land Resources			
Land use(ha)	• Gross area:8,498 • NCA :7,438 • Others:1,060	• Gross area:8,498 • NCA:7,427 • Others:1,071	• NCA:-11 • Others:+11
Land degradation	No	No change	No change
Agriculture Resources			
Cropping intensity (%)	100	100	No change
Cropped area (ha)	• Rice: 7,438 (Boro: 7,438) • Non Rice: 0	• Rice: 7,427 (Boro: 7,427) • Non Rice: 0 •	• Rice:-11 (Boro: -11) • Non Rice: 0 •
Crop production (ton)	• Rice: 22,686 (Boro: 22,686) • Non Rice: 0	• Rice: 37,090 (Boro: 37,090) • Non Rice: 0	• Rice:+14,405 (Boro: +14,405) • Non Rice: 0
Crop damage (ton)	• Rice: 1,116 • Non Rice: 0	• Rice: 5,838 • Non Rice: 0	• Rice:+4,722 • Non Rice: 0
Irrigated area (ha)	• Rice: 7,438 • Non Rice: 0	• Rice: 7,427 • Non Rice: 0	• Rice:-11 • Non Rice: 0
Surface water Irrigation availability	Available	Deficit during month of February to March	Deficit
Agro-chemicals use (ton or kiloliter)	• Fertilizers: 0 • Pesticides: 0	• Fertilizers: 1,730 • Pesticides: • Granular: 31 • Liquid:1.541	• Fertilizers: +1,730 • Pesticides: • Granular: +31 • Liquid:+1.541
Livestock Resources			
Livestock population (number)	• Cow/Bullock:6,780 • Goat:530 • Chicken:11,350 • Duck:11,120	• Cow/Bullock:8,850 • Goat:280 • Chicken:12,160 • Duck:7,300	• Cow/Bullock:2,070 • Goat: -250 • Chicken:810 • Duck:-3,820
Fisheries Resources			
Fish habitat area	• Total fish habitat area- 7,929 ha • Habitat area breakdown: ○ Khal- 195 ha ○ Beel- 249 ha ○ Floodplain- 7,438 ha ○ Fish pond- 2 ha ○ Baor- 45 ha	• Total fish habitat area- 8,143 ha, • Habitat area breakdown: ○ Khal- 204 ha ○ Beel- 217 ha ○ Floodplain- 7,427ha ○ Borrow Pit- 250 ha ○ Fish Pond- 3 ha ○ Baor- 42 ha	• Gain of total fish habitat area by 214 ha (Increased Khal area and newly created borrow pit)
Fish habitat condition	• Habitat quality and suitability condition was in favor of fisheries; • Maintained unregulated ecosystem with better provisioning (i.e., fish) and supporting (i.e., fish nursery and breeding	• Habitat quality and suitability condition becomes little degraded; • Regulated ecosystem with somewhat degraded and unsuitable habitat	• Slightly degraded habitat condition driving towards relatively less sustainable mentioned provisioning and supporting services.

Indicators	Pre Project	Post Project	Impact
	grounds) services like sustainable fisheries.	condition particularly for Beel resident fishes; • Increased pollution load due to intensified Boro cultivation.	
Fish Diversity	• More or less evenly distribution of fish species over the area.	• Abundance of some biologically and commercially important fish species become low or rare locally; • Population of bentho-pelagic like *Notopterus chitala*, *Labeo calbasu*,*Labeo rohita*, etc. and demersal fish species like *Heteropneus fossilizes, Clarius batrchus*, *Channa punctatus, Channa marulius Macrognathus aculeatus*, etc. become affected more due to dewatering of Beels and indiscriminate fishing in Beel leasing system; • Increased abundance of SIS fish species.	• Little imbalance in fish species distribution over the area; • Vulnerability to Beel resident bentho-pelagic and demersal fish species; • Possible inbreeding problem due to increase of culture exotic fish species.
Fish migration	• Unregulated lateral fish migration from river to floodplain and floodplain to river through Khal; • Regulated lateral fish migration from internal Khal to Beel and Beel to Khal by making earthen closure at the mouth of Khals by Beel Leaseholders (LH).	• The scheme is almost fully functional. For this reason, fish migration from river to Beel and Beel to river in the pre-monsoon season is being obstructed due to embankment and water control structures.	• There is significant implication of interventions on fish migration particularly for SIS.
Fish production	• Fish production in 1989 was about 764 metric ton.	• Fish production in 2015 was about 3,341 metric ton.	• Overall fish production gain is about 2,577 metric ton in 2015 compared to production of 1989.
Fishing Appliances	• Sustainable fishing was done using suitable mesh sized fishing gears. • Use of Kona Jal /Mosquito net (small mesh sized net) was not reported.	• Unsustainable fishing is being done using small mesh sized fishing gears like Kona Jal /Mosquito net (mesh size in mm); • Fishing pressure at	• Increased use of unconventional fishing appliances and thus increased fishing pressure.

Indicators	Pre Project	Post Project	Impact
	• Fishing pressure at the mouth of the Khals during recession period were very low except leased Beel connecting Khals (only by LH).	the water structure points during recession period is more because of engagement of mass people.	
Fishers Livelihood	• Commercial fishers were dominant in floodplain fish habitat meaning livelihood fully dependent on fishing. • Fishing people were less.	• Part-time fishers become dominant in floodplain fish habitat meaning carrying livelihood with fishing is not adequate and need other income generating activities. • Fishing people are more.	• Fishing based livelihood of commercial fishers becomes unsustainable due to dominancy of part-time fishers.
Fisheries Management	• Beel fishery maintained three-year rotation in harvesting fish; • Fish got more time for propagation and grow up; • Sustainable fishery.	• Beel fishery is being maintained mostly one-year rotation in harvesting fish. • Fish is not getting enough time for propagation and grow up; • Unsustainable fishery.	• Beel fishery is being secured by the scheme though the weak enforcement is not yielding expected benefit.
Ecosystem			
Terrestrial flora	Floral diversity was remarkable.	Floral diversity enriched specially on homesteads and ridge vegetation	Overall floral diversity and coverage are insignificant changed
Terrestrial fauna	Faunal diversity and coverage were pretty high.	Faunal diversity has been dropped over time.	Faunal habitat deteriorated most of the area for different anthropogenic activities except eastern portion of the haor.
Aquatic flora	Aquatic floral diversity were enriched especially free floating and rooted floating plants were abundant	Aquatic floral diversity have reduced over time	Overall aquatic floral diversity has been changed due to over extraction, agriculture expansion and other anthropogenic activities
Aquatic fauna	Aquatic faunal species were enriched throughout the area	Aquatic faunal community have changed and reduced over time	Overall faunal diversity and coverage are insignificant changed
Swamp Forest and Reedland	No swamp forest but reeds coverage specially on binna, Ikor, Nol, khagra etc. and their density were enriched	Wetland trees and reeds have changed positively at eastern part but remaining areas of the haor lost swamp forest and reed land density and coverage	Over harvesting of economically valuable plants, Reed land has converted to agricultural land. No direct link with intervention.
Ecosystem goods and services	Ecosystem goods and services were in optimum level.	Deteriorate over time for different anthropogenic activities.	Overall ecosystem goods and services have changed negatively.

Indicators	Pre Project	Post Project	Impact
Socio-economic Conditions			
Employment Opportunity	• Total cropped area was 7438 ha whereas about 120 man days labour (per hector) inputs were needed.	• Total cropped area were 7427 ha where about 165 man days labor input were needed (technological use)	• Additional employment opportunity has been created due to HYV culture of paddy • New employment opportunity had been created with the increase of agricultural production
Agriculture and wage base income	• The total agricultural production value at current price was BDT 3630 lakh • The agricultural wage income was about BDT 2678 lakh.	• The total agricultural production value at current price after project is BDT 5935 lakh • The agricultural wage income is about BDT 3598 lakh	• Agricultural production base income was increased due the project intervention. • Agricultural wage labor income increased during the period of after project condition.
Land Price	• The price of agricultural land was 6000 to 7000 Tk per Keyar and that of homestead land was between BDT 10,000 to 12,000 only	• The price of agricultural land is near to be 1.5 lakh to 2.0 lakh per Keyar whereas the price of 2.0 lakh to 3.0 lakh for homestead lands.	• Asset value of land has appreciated for all land owning households, making them more credit worthy for more assets to own.
Accessibility in Health and Educational institution	• It was tough to go to schools and health institutions especially in the wet season.	• People started to use the embankments as their way of communication. • With the damage of certain locations of the embankments people felt insecured to use their way of moving during the rainy season. • School going children sometimes fall in problem in using breached embankments as their way to go to schools.	• The communication system rendered people comfortable at least during dry season but frequent breaches have left them uncertain about using embankment as road as long as these are not submerged.
Institution and Governance	• Local Union Parishad used to manage local water resources and beels and haors were managed by Deputy Commissioner at district level.	• The institutions (i.e. WDB) constructed embankments and has been conducting O&M of infrastructures • Local people's participation in planning and management has been insufficient land hence governance ineffective.	• Institutional presence (of BWDB) is seen but efficiency of flood control system is at the low ebb. • In absence of participatory management body within haor, the governance position does not turn out meaningful.

10 Environmental Management Plan

10.1 Management Plan

Impact	Mitigation Measures	Enhancement Measures
Flooding	• The submersible embankment should be repaired as per design section within the month of February every year. • Causeway should be constructed at suitable locations to avoid major damage of embankment by public cuts. • The beels, khals and rivers should be dredged/ re-excavated to increase carrying capacity.	
Drainage	• Internal khals and peripheral rivers should be re-excavated and required number of sluices should be constructed. • Sluice Gate at Naziapur should be repaired for the betterment of local stakeholders.	
Sedimentation	• Sedimentation from the bottom of the regulators and sluices should be removed. • The surrounding rivers and channels should be re-excavated	
Navigation	• Some *ghats* should be constructed at suitable locations and some navigation friendly culverts or boat pass should be constructed over the embankment.	
Land use change	• Agricultural land graving should be avoided. • Fallow land should be brought under cultivation	-
Decreased cropped area	-	• Raise the height of the submersible embankment up to 2 to 3 feet at Anandapur to Ghungirgaon (Bahar) locations. • Complete the rehabilitation work by the months of December-February • Kanda should be utilized for vegetables cultivation. • Hydroponics or floating bed vegetables cultivation should be introduced. • Medium low land should be utilized for short duration and submergence tolerant T Aman (BINA dhan7, BINA dhan 11, BINA dhan12 and BINA dhan 13) cultivation. • Flood tolerant submergence

Impact	Mitigation Measures	Enhancement Measures
		variety (BRRI dhan51, BRRI dhan52 and BRRI dhan79 may be tested.
Increased crop production	-	• Crop area should be increased by utilization of fallow land. • Short duration high yielding and hybrid varieties should be developed/introduced/strengthened • Crop damage should be minimized by timely and proper rehabilitation of water control structures like embankment , regulators etc.
Decreased irrigated area and Availability of irrigation water	Regular re-excavation/dredging of Mara Gang and Surma river has to be ensured in order to retention of irrigation water.	• Re-excavation of existing beels and khals should be ensured for retention of irrigation water. • Irrigation water should be ensured by stopping drain out the beels during early dry season for fish harvesting.
Status of livestock/poultry		• Grazing area should be increased by utilizing fallow land. • Awareness buildup through training • Marketing facilities should be improved. • Availability of high yielding breed should be ensured.
Increased crop damage	• Establishment of sluice gates on Mauti khal under Sultanpur mouza. • Regular dredging of the rivers has to be ensured in order to reduce the intensity of flash flood. • Rehabilitation works should be finished by February • Quality materials should be used for rehabilitation works. • Short duration high yielding or hybrid varieties should be used instead of long duration BRRI dhan29 variety. • Local varieties should be transplanted in the deeper part of the haor area instead of short height high yielding or hybrid variety.	
Increased use of agro-chemicals	• Farmers should be encouraged to use organic manure to increase soil fertility while avoiding water contamination and reduce the soil fertility. • Farmers should be encouraged to cultivate leguminous crops to enhance the soil quality. • Farmer should be follow modern agricultural technology like	

Impact	Mitigation Measures	Enhancement Measures
	Integrated Pest Management/Integrated Crop Management(IPM/ ICM), Good Agricultural Practices (GAP) etc.	
Gain of total fish habitat area by 214 ha		• Re-excavation of internal Khals and channel and seasonal Beels
Slightly degraded fish habitat condition driving towards less sustainable provisioning services majorly fisheries.	• Water holding capacity in the Khals and in some cases in the Beels (i.e., Kabla Beel, Khara Beel, Khash Beel, Sissani Beel, Atra Beel, Ganuki Beel etc.) should be increased through re-excavation/ dredging; • Maintain minimum 1 m water depth in almost all water bodies during dry season.	• Not applicable
Vulnerability to Beel resident bentho-pelagic and demersal fish species	• Unconventional fishing appliances (i.e., fine meshed gears, dewatering, poisoning, etc.) should be banned; • Should motivate and encourage agriculture sector people for abstaining from use of chemical fertilizers and pesticides for keeping water uncontaminated.	• Beel nursery programme with native fish species should be increased; • Build more sanctuary with the involvement of adjacent fishers community; • The protected area should be guarded especially at night by the professional fishers of adjacent village for facilitating fish species diversity and fish propagation.
Significant implication of interventions on fish migration.	• Increase the conveyance capacity of Khal maintaining minimum 1m depth during dry season; • Fish friendly structures should be implemented for suitable fish passage. • Fishing should be controlled during pre-monsoon and recession period.	• Proper maintenance work should be conducted and monitored by the Project Implementation Committee (PIC). • Monitoring and awareness building activities should be conducted through fishers' communities under the guidance of Upazila Fisheries Officer.
Overall fish production gain is about 2577 metric ton in 2015 compared to production of 1989.	-	• Beel fishery should be promoted with three-year rotation; • Beel dewatering should be stopped.
Increased use of unconventional fishing appliances and thus increased fishing pressure.	• Unconventional fishing appliances should be stopped; • Should increase law enforcement for controlling unlawful fishing. • Strong surveillance for maintaining water control structures through controlling fishing.	• Not applicable
Fishing based livelihood of commercial fishers becomes unsustainable due to dominancy of part-time fishers.	• Fishing ban time income generating activities should be promoted. In that case, the fisher's community should be involved in water management group.	• Not applicable
Beel fishery is being secured by the scheme though the weak	• The scheme should be maintained with the coordination of the line agencies.	• Not applicable.

Impact	Mitigation Measures	Enhancement Measures
enforcement is not yielding expected benefit.		
Overall floral diversity and coverage are insignificant changed	• Plantation of local species in the project areas (i.e. Settlement ridge, Roadside, Kandas etc.) as early as possible. • Tree based farming • Use of natural fertilizer	• Local species should give preference for all types of plantation.
Faunal habitat deteriorated most of the area for different anthropogenic activities except eastern portion of the haor.	• Avoid killing of animals • Use of natural fertilizer	• Aware local people for indigenous tree plantation and conserving wildlife • Initiate plantation programme along the river levees, kandas and other khash lands
Overall aquatic floral community has been changed due to over extraction, agriculture expansion and other anthropogenic activities	• Aware local people about the importance of aquatic resources • Control over harvesting of aquatic plant resources	
Overall faunal diversity and coverage have been insignificantly changed	• Aware local people about conservation of aquatic animals and their sustainable harvesting of aquatic flora. • Use of natural fertilizer in the land	
Over harvesting of economically valuable plants, Reed land has converted to agricultural land.	• All the khash land with swamp forest and reedlands should be out of public lease and allotments	• Local household should be involved in transit nursery program for proper seed germination and saplings collection. • BFD, BWDB, local people, local nursery owner should be properly involved in the collaboration of plantation program inside the haor area • Create new swamp forest area
Overall ecosystem goods and services have reduced	• Conservation of reed land and important wetland areas • Avoid over harvesting of economically valuable plants • Use of natural fertilizer	
New employment opportunity had been created with the increase of agricultural production Employment opportunity has been created during the period of operation and maintenance of those projects in Chayer haor.	-	• Training would be ensured for the creation of alternative livelihood options • Submergible embankment must be repaired using the local labor • Allocation of all beel /Jall Mohal to the actual fishermen on equity basis • Soft loan would be provided especially in the emergency period (i.e. post flooding condition) • Build up linkage with farmer and national, international traders
(Agriculture and wage based income)	-	• New variety of crops and its profitable production should be

Impact	Mitigation Measures	Enhancement Measures
Agricultural production based income increased due the project intervention. Agricultural wage labor income increased with project.		ensured among farmers. Appropriate training programs should be initiated for farmers to cope up with the changing climate and technology
(Land Price) The opportunities for agricultural production increased for which the value of agricultural lands is also increasing		• Regular Operation and Maintenance (O&M) and riverbank protection work should be continued properly to keep the land optimally productive.
• (Accessibility to Health and Educational institution) • The submergible embankments provided opportunity to be used as road with project intervention. • Due to lack of proper maintenance, the damage of the embankments was increased and local people started to face problem to use these embankments as their means of communication.	-	• A monitoring Committee should be formed in association with WDB and local people to identify damaged parts of the embankment • Local participation has to be ensured to repair minor damages to embankment.
• (Institution and Governance) • There is no mechanism to consider local people's ideas and concerns while drawing project operation and maintenance systems. Project people suffer crop loss and other household vulnerabilities. • The role of institution to consider public demand in policy, operation and maintenance on the issue of those submergible embankments.	• Quarterly Meeting should be initiated with local water and flood protection committee to understand the gap of institutional policy and governance • A Monitoring team should be formed to visit submergible embankments • People's feedback should be taken before the implementation of any kind of policy in relation to new project and maintenance and operation of those submersible embankments.	

Appendix: A

Table A1: Availability of Major Fish Species in Chayer Haor

Sl. No.	Local Name	Scientific Name	IUCN Status, 2015
1	Ayre	*Sperata aor*	VU
2	Baila	*Glossogobius giurus*	LC
3	Bajari Tengra	*Mystus tengara*	LC
4	Barobaim	*Mastacembalus armatus*	EN
5	Boal	*Walla goattu*	VU
6	Catla	*Catlacatla*	LC
7	Chapila	*Gudusia chapra*	VU
8	Chang	*Chana orientalis*	LC
9	Chital	*Chittala chittala*	EN
10	Darkina	*Esomus dandicus*	LC
11	Ghoinya	*Labeo gonius*	NT
12	Gojar	*Channa marulius*	EN
13	Gutum	*Lepidocephalichthys guntea*	LC
14	Kabashitengra	*Mystus cabasius*	NT
15	Kaikla	*Xenentodon cancila*	LC
16	Kajuli	*Ailia coila*	LC
17	Kalibaus	*Labeo calbasu*	LC
18	Kanipabda	*Ompok bimaculus*	EN
19	Kashkhaira	*Chela laubuca*	LC
20	Katari Chela	*Salmostoma bacaila*	LC
21	Kholisa	*Colisa fasciatus*	-
22	Koi	*Anabas testudineus*	LC
23	Kuchia	*Monopterus cuchia*	VU
24	LalChanda	*Chanda ranga*	-
25	Lalkholisa	*Colisa lalius*	-
26	Magur	*Clarias batrachus*	LC
27	Mrigal	*Cirrhinus mrigala*	NT
28	Mola	*Amblyphayngodon mola*	LC
29	Nandil, Nandi, Nandina	*Labeo nandina*	CR
30	Napit koi	*Badis badis*	NT
31	Potka	*Tetradon cutcutia*	LC
32	Rani	*Botia dario*	EN
32	Rita	*Rita rita*	EN
33	Rui	*Labeo rohita*	LC
34	Shilong	*Silonia silondia*	LC
35	Shing	*Heteropneus fossilies*	LC
36	Shol	*Channa striatus*	LC
37	Tara baim	*Macrognathus aculatus*	NT
38	Tengra	*Mystus vittatus*	LC
39	Tit puti	*Puntius ticto*	LC
40	Veda/ Mani	*Nandus nandus*	NT
	Etc.		

Appendix: B

Photo Album

Water Resources

Agriculture Resources

Fisheries Resources

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Socio-economic Resources

Focused Group Discussion

Dhaleswai River

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1. Introduction

1.1. General Information

Dhaleswai River Project is situated in between latitude 25°10'17.90"N and 25° 7'13.19"N and between longitude 92° 0'41.86"E and 92° 3'3.24"E under Purbo-jaflong Upazila of Sylhet District. The project has a gross area of about 1,443 ha, of which 292 ha is occupied by rural settlement, 38 ha is waterbodies, 1083 ha is harbeceous crops and 30 ha is occupied by sand.

The water resources system of the project comprises rivers and khals flowing along the periphery as well as through the project area. The project also encompasses a number of smaller haors namely Ashampara Haor and Sankivanga Haor.The Sarigowain river is situated in the east side and flows towards the south, the Dauki river is situated in the west and also flows towards south and have met with the Sarigowain river. Among the Dauki, Goyan, Naljor and Sari rivers, Dauki carries more water compared to the others. There are some beels and khals inside the project namely Kakai Beel, Hidoli Beel etc and Dhaleswary khal, Cheliakhali Khal, Nalijuri Khal, Sanker Khal and Hidulikhal, whicht are important perennial wet lands of the project and serve as the main source of fish habitat and irrigation during dry season.

1.2. Project Descriptions

Bangladesh Water Development Board (BPDB) implemented the Dhaleswai River Project during 2005-06 with GOB fund. The main objective of the project was to protect crops from flash flood as well as to protect life and properties from flooding. The major physical interventions of the project are 5 km submersible embankment, 8-vent sluice gate on *Nalijuri khal*, *Sankivanga* 1 vent regulator and 3 km drainage canal.

1.3. Present Status of the Project Interventions

The area normally suffers from flash flood in mid-April due to excessive rainfall in the Meghalaya. But, sometimes the flood occurs earlier like it happened in 2017 due to severe rainfall both in the upstream region and also inside the country. The farmers also cut the embankment to expedite the drainage after flood to start cultivation in dry areas. Moreover, the embankment also gets breached due to heavy onrush of flash flood. If the breached points or public cuts are not repaired in due time i.e. before onset of flash flood, flood water enters into the project through these weak points and damages crops.

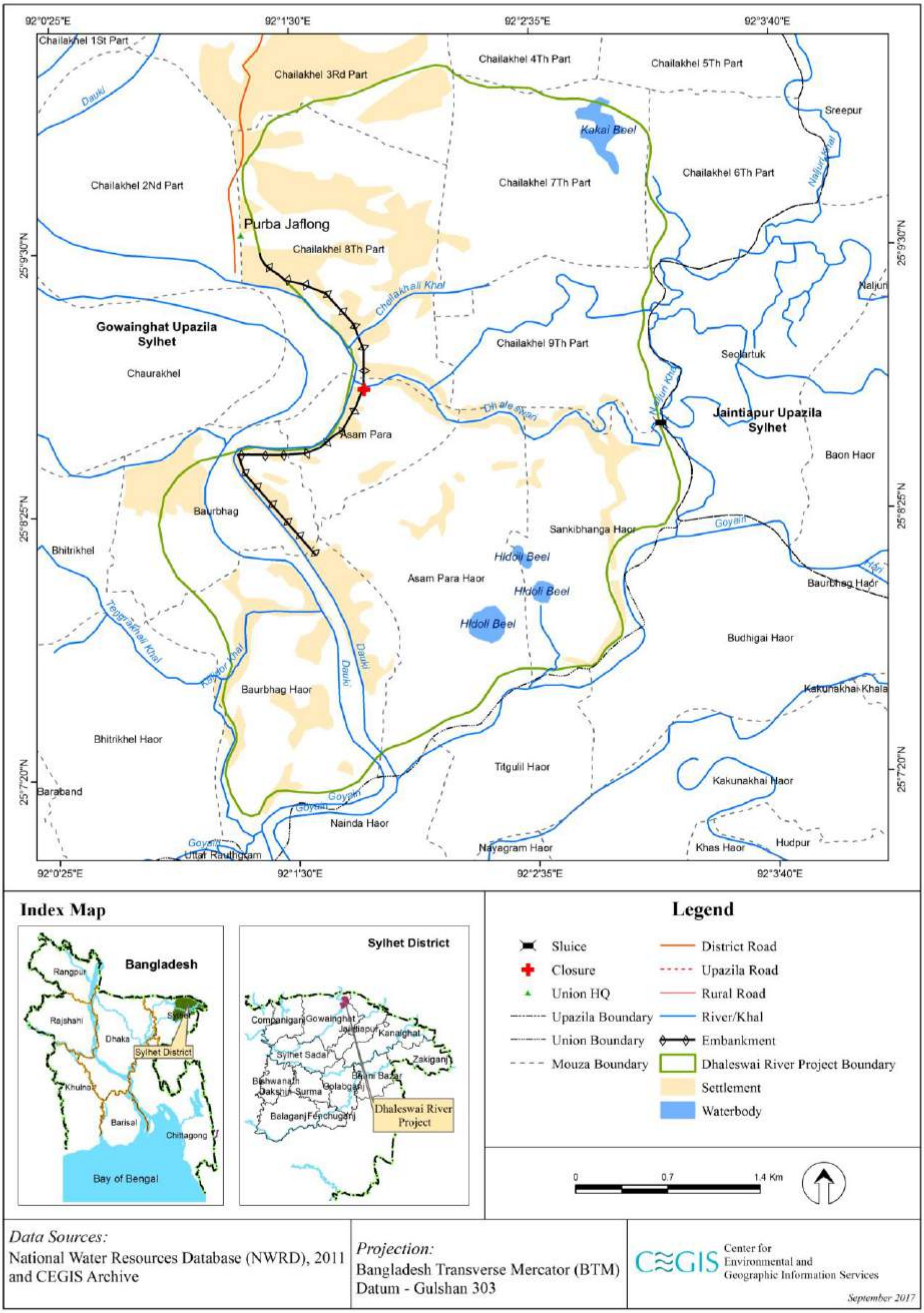

Figure 1.1: Hydrological Features of Dhaleswai River

2. Water Resources

2.1. Flooding Situation

Pre Project

Before construction of the project interventions, flash floods due to heavy rainfall in the upstream region during pre-monsoon period flowed through the Dauki River. Usually the flash flood entered in mid-April and at times in mid-March and water stayed up to five to six months in the project area.

Post Project

After implementation of the project, the entry of water due to flash flood got delayed by 15-20 days. Afterwards, water normally enters through the Nalijuri khal, Sarigowain river and public cuts during early May. Thereafter, monsoonal flood comes and continues till the end of September. However, due to unprecedented rainfall in the upper catchment in Meghalaya, the flash flood sometimes comes early like; it happened in mid-March in 2016 and 2017. Recession of floodwater starts from September and by the mid of October most of the water gets drained out except beel areas.

Impact

Interventions of the project have delayed the entrance of flash flood by 15-20 days. However, in recent years (2016 & 2017), flash flood entered into the project a bit early due to unprecedented rainfall in the upper catchment both in the upstream region and also inside the country. The farmers also cut the embankment to expedite the drainage after flood to start cultivation in dry areas. Moreover, the embankment also gets breached due to heavy onrush of flash flood. If the breached points or public cuts are not repaired in due time i.e. before onset of flash flood, flood water enters into the project through these weak points and damages crops.

Figure 2.1: Dauki River Bank Protection

Figure 2.2: Active Sluice (8V) on Nalijuri

Figure 2.3: Regulator (1V) on Dhaleswai

Figure 2.4: Box Culvert (1V) in Kalinagar

2.2. Drainage Condition

Pre Project

The elevation of the north and north-western portion of the project is relatively higher than the south-eastern part. The slope (1 meter per kilometer) helped drainage of flood water as there was no embankment and the entire area was open. Besides, the permeable soil expedited infiltration and thereby reduced flood depth. As a result, during pre-project period, it took about 2-3 months after monsoonal flood to drain the water to the Dauki River.

Post Project

The prolonged sedimentation at both upstream and downstream of the outlet strictures, and the embankment around the project area impedes drainage of water. Local people informed that after construction of the intervention, drainage congestion had occurred frequently after 2006 for a short duration only in the southern low lying portion (Sankivanga Village) of the project. Over the years, the bed levels of the rivers and internal khals have risen due to continuous sedimentation. Some drainage khals namely *Nalijuri Khal, Hidoil Khal, Dhaleswai Khal* mainly control the drainage system of the project are being silted up and are gradually losing their conveyance capacity. The farmers sometimes cut the embankment to expedite draining out of water.

Impact

The drainage has been affected due to siltation at both upstream and downstream of the outlet strictures, and also due to existence of the embankment around the project area. Presently, draining of water has been delayed by 20-25 days.

2.3. Sedimentation and Siltation

Pre Project

During pre-project period, the flash flood used to carry silt and other coarse materials, most of which got deposited in the rivers as well as in the project area.

Post Project

After construction of submersible embankment, the silt and other coarse materials cannot enter the project area during flash flood due to submersible embankment which is mostly deposited in the river. However, sometimes, the silts and other coarse materials enter the project through the breached point and public cut, if not repaired in due time. The bed levels of the rivers, internal khals and low-lying beels have been rising and the shifting the river bank alignment over the years The Dauki river is being shifted towards east in the *Baurbhag* Haor village and continuously pushing the village in *Ashampara* Haor People in the *Ashampara* Haor protects the riverbank by sand bag.

Impact

Sedimentation in both peripheral rivers and internal rivers and khals has increased compared to pre-project period. Presently, on average, the rate of sedimentation each year is about 12-20 cm in the rivers and about 5-7 cm in khals as well as beels which was 6-8cm in rivers and 4-5cm in khals and beels in pre-project period.

2.4. Navigation

Pre Project

During pre-project period, there was navigational connectivity between the haor and the peripheral rivers throughout the year.

Post Project

Navigational connectivity between the haor and the peripheral rivers mainly remains operative during monsoon. Besides, navigation also operates through the breached points and public cuts (if it happens) before repairing in February/March. Moreover, boats can ply within the haor for fishing and other purposes. However, navigational connectivity does not persist during pre-monsoon due to repairing of submersible embankment.

Impact

The navigational connectivity has not been affected in monsoon but it does not operate during pre-monsoon. But at the same time, the road communication around the periphery of the project has developed.

3. Land Resources

The project area has fallen in one Agro-ecological zone, namely: Northern and Eastern Piedmont Plains (AEZ-22). Grey piedmont soil and non-calcareous grey floodplain soil (non-saline) are the dominant soil. The top soil texture is clay, clay loam, loam and sandy loam; where clay loam texture is dominant. The soils are slow to moderate permeable and have a medium moisture holding capacity. The land type characteristics are not uniform within the project area. About 78% of cultivable areas are medium to high land where maximum flooding depth is below 90 cm during the monsoon period. The recession of surface water from agriculture land starts at first week of October and become free of floodwater in end of December.

Two indicators (Land use and Sand carpeting area) have been selected for assessing the impact on land resources due to structural interventions in haor ecosystem. The land use and sand carpeting information under pre-project and existing situations were identified through analysis of the available archived satellite images of CEGIS and it was verified through Focus Group Discussion (FGD) and Key Informant Interview (KII).

3.1. Land Use

Pre Project

The gross area of Pre Project has been considered as similar to Post Project. The gross area was 1,443 hectares under pre-project situation of which Net Cultivated Area (NCA) was 1,035 hectares. The rest area was covered with waterbodies (baor, beels, river and khals), forest (herb, shrub and tree) and settlements including homestead vegetation. Details are presented in **Table 3.1**.

Post Project

The gross area remaining same and the Net Cultivated Area (NCA) is 1,083 hectare. The rest area is covered with waterbodies (baor, beels, river and khals), forest (herb, shrub and tree), and settlements including homestead vegetation. Details are presented in **Table 3.1**.

Impact

Waterbodies has decreased about 78 hectare. On the other hand, net cultivated area has increased about 48 hectare. Detailed impacted area is presented in **Table 3.1**.

Table 3.1: Detailed Land use in Dhaleswai River System

Land use	Pre-project area(ha)	Post Project area(ha)	Impact (Post Project-Pre Project)
Net Cultivable Area (NCA)	1,035	1,083	48
Water bodies	116	38	-78
Settlement	290	292	2
Others	2	30	28
Total	**1,443**	**1,443**	**0**

Sources: Analysis 30 m Resolution Landsat Satellite Images, March: 1989 and 2015

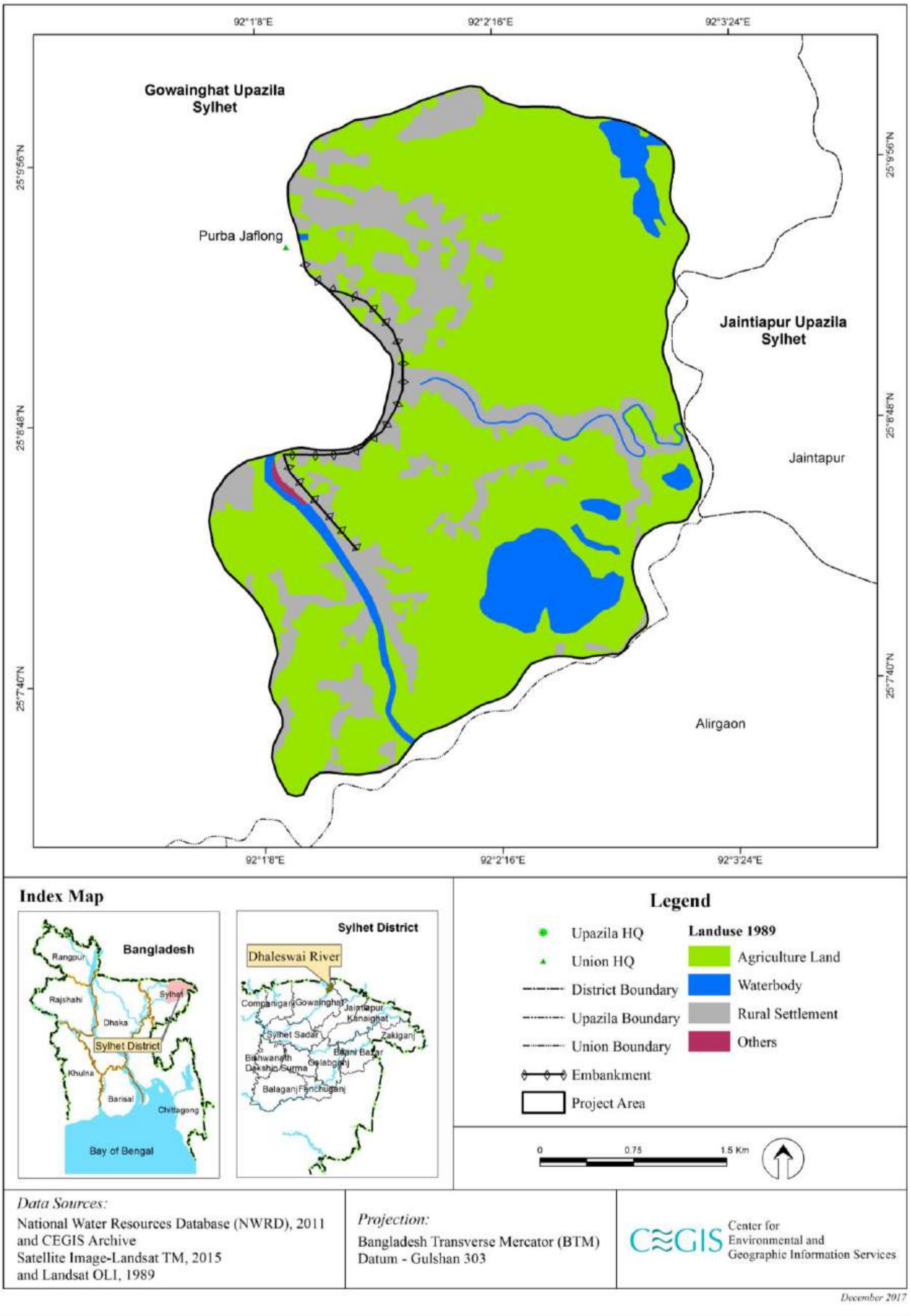

Figure 3.1: Landuse of Dhaleswai River (1989)

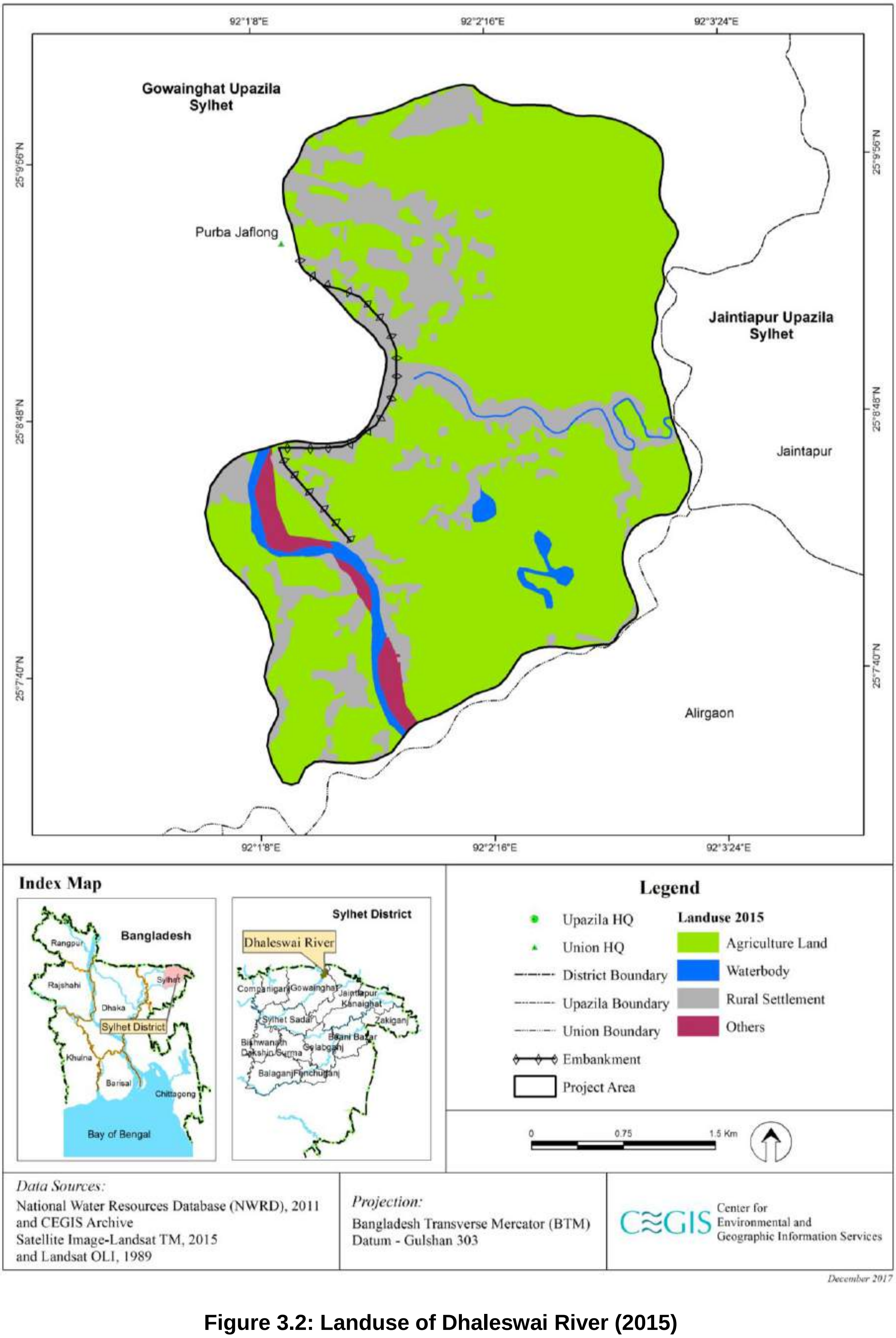

Figure 3.2: Landuse of Dhaleswai River (2015)

3.2. Land Degradation

Pre Project

Local farmers are reported that, in without project condition they are observed sand carpeting in Nowagaon and Asampara Haor area. Its total about 15 ha land were carpeted by sand. After the sand carpeting land cannot use for agricultural crop production or grazing land for livestock.

Post Project

In with project condition, there was no sand carpeting in Nowagaon and Asampara Haor and sedimentation was observed in this sand carpeted area. So, now farmers are started to vegetables (Potato) cultivation in this land.

Impact

In with project condition, total 15 ha sand carpeted area converted to agricultural land due to sedimentation. Sedimentation was occurred instead of sand carpeting due to control condition of this area.

4. Agriculture Resources

Boro rice is the main crop in Haor areas. In most cases, pre-matured or matured Boro crops are damaged by early flash flood which generally happened due to pre-monsoon heavy rainfall in the hilly areas. Besides, drainage congestion and irrigation water scarcity due to siltation of rivers, Khals and Beels are the another problem for Haor agriculture.

Six indicators (cropping intensity, crop area, crop production, crop damage, irrigation and use of agro-chemicals) have been selected for assessing the impact on agriculture resources due to structural interventions in Haor ecosystem. The information of these indicators were collected from both primary and secondary sources. The primary data were gathered from stakeholders through Focus Group Discussion (FGD) and Key Informant Interview (KII). The secondary data were collected from Bangladesh Bureau of Statistics (BBS) and field level Department of Agricultural Extension (DAE) office. Besides, Boro crop areas under pre and Post Project situation were identified by analyzing satellite images.

4.1. Cropped Area, Cropping Pattern and Intensity

Pre Project

Before the project interventions, the Net Cropped Area (NCA) was 1,035 hectare, where dominant cropping pattern was Fallow-Lt. Aman-Fallow. The land type of this scheme area was medium high land (about 66% of NCA) followed by high land, medium low land, low land as presented in **Table 4.1**.

Farmers usually grew Lt. Aus, B. Aus, B. Aman, Lt. Aman and vegetable crops in Kharif-I, Kharif-II and Rabi season. Different varieties ofAus like Putia, Kala Manik, Chitki Haita, Hasakumuria, Haowa and Hasbadal (B. Aus); Aman like Agni Shail, Moina Shail, Balam, Motanga, Joldugi, Kala Koira, Ecor Shail, Abul Hasem and Badal (B. Aman) were very much popular among the farmers. The cropping intensity of this area was 116%. Detailed cropping pattern by land type under pre-project situation is presented in **Table 4.1**.

Table 4.1: Pre Project Cropping Pattern of the Dhaleswai River System

Land type	Kharif-I (March-June)	Kharif-II (July-October)	Rabi (November-February)	Area (ha)	% of NCA
High Land (F_0)	Fallow	Fallow	Vegetables	52	5
	Fallow	Lt. Aman	Fallow	72	7
Medium High Land(F_1)	Lt. Aus	Lt. Aman	Fallow	155	15
	B. Aus	Lt. Aman	Fallow	114	11
	Fallow	Lt. Aman	Fallow	414	40
Medium Low Land(F_2)	Fallow	B. Aman	Fallow	124	12
Low Land(F_3)	Fallow	Fallow	Fallow	104	10
Total				**1,035**	**100**

Source: CEGIS estimation based on field information, September; 2017

Post Project

The project area became protected from early flash flood due to the interventions, which influenced farmers to grow HYV Aman, Lt. Aman, Hybrid Boro and HYV Boro crops instead of local Boro. HYV/Hybrid crops also produces higher yield than local varieties. The most popular varieties which are used in the project area are BRRI dhan 28, BRRI dhan 29 and BRRI dhan48. Farmers prefer, Lt. Aman: Kala Koira, Giri, Ecor Shail and Abul HasemHYV Aman: BR 11, BRRI Dhan 40, BRRI Dhan 49, BRRI Dhan 52 in Kharif-II season, HYV Boro: BRRI dhan 28, BRRI dhan 29 in Rabi season. The Net Cultivable Area (NCA) has been decreased to 1,083 hectare after interventions. Dominant cropping pattern of the project area is Fallow – HYV Aman - Fallow covering 40% of the NCA. Cropping intensity of the area is 118%. Detailed cropping pattern by land type under with project situation is presented in **Table 4.2**.

Table 4.2: Post Project Cropping Pattern of the Dhaleswai River System

<table>
<tr><th>Land type</th><th>Kharif-I (March-June)</th><th>Kharif-II (July-October)</th><th>Rabi (November-February)</th><th>Area (ha)</th><th>% of NCA</th></tr>
<tr><td rowspan="2">High Land (F_0)</td><td>Fallow</td><td>Fallow</td><td>Wheat</td><td>54</td><td>5</td></tr>
<tr><td>Fallow</td><td>Fallow</td><td>W. Vegetables</td><td>76</td><td>7</td></tr>
<tr><td rowspan="3">Medium High Land(F_1)</td><td>Fallow</td><td>HYV Aman</td><td>Fallow</td><td>433</td><td>40</td></tr>
<tr><td>Fallow</td><td>Lt. Aman</td><td>Fallow</td><td>217</td><td>20</td></tr>
<tr><td>Fallow</td><td>Lt. Aman</td><td>Hybrid Boro</td><td>65</td><td>6</td></tr>
<tr><td rowspan="2">Medium Low Land(F_2)</td><td>Fallow</td><td>Lt. Aman</td><td>HYV Boro</td><td>76</td><td>7</td></tr>
<tr><td>Fallow</td><td>B. Aman</td><td>HYV Boro</td><td>54</td><td>5</td></tr>
<tr><td>Low Land(F_3)</td><td>Fallow</td><td>Fallow</td><td>HYV Boro</td><td>108</td><td>10</td></tr>
<tr><td colspan="4">Total</td><td>1,083</td><td>100</td></tr>
<tr><td colspan="4">Cropping intensity (%)</td><td>118</td><td></td></tr>
</table>

Source: CEGIS estimation based on field information, September; 2017

Impact

The Net Cultivable Area (NCA) has been decreased to 48 hectare after taking interventions. The cultivated area of B. Aman has gradually been decreased and replaced by either HYV or Lt. Aman, HYV and Hybrid Boro variety after completion of project due to its higher yield rate and ensured early flash flood protection by project interventions. Impact on cropped area is presented in **Table 4.3**.

Table 4.3: Impact on Cropped Area in Dhaleswai River System

Crop name	Pre Project Area(ha)	Post Project Area(ha)	Impact (Post Project-Pre Project) Area(ha)
B. Aus	114	-	(114)
Aus	155	-	(155)
B. Aman	124	54	(70)
Lt. Aman	756	358	(398)
HYV Aman		433	433
Hybrid Boro		65	65
HYV Boro		238	238
Wheat		54	54
Vegetables	52	76	24
Total	**1,201**	**1,278**	**77**

Source: CEGIS estimation based on field information, September; 2017

4.2. Crop Production

Pre-project

The estimated total annual crop production of the project area was about 2,982 tons after loss of 534 tons before any interventions. Detailed crop production statistics before interventions is presented in **Table 4.4**.

Table 4.4: Annual Crop Production in Dhaleswai River System under Pre-project Situation

Crop name	Total crop area (ha)	Damage free area		Damaged area		Annual production (ton)	Production lost(ton)
		Area(ha)	Yield (ton/ha)	Area(ha)	Yield (ton/ha)		
B. Aus	114	97	2.0	17	1.0	211	17
Aus	155	124	2.1	31	0.7	283	43
B. Aman	124	106	1.9	19	1.0	219	17
Lt. Aman	756	589	2.1	166	0.6	1,337	249
Vegetables	52	39	22.0	13	6.0	932	207
Total	**1,201**	**955**	**-**	**246**	**-**	**2,982**	**534**

Source: CEGIS estimation based on field information, September; 2017

Post Project

After the implementation of the project, hydrological regime of the project area is changed. Farmers started to cultivate HYV Aman, Lt. Aman, Hybrid Boro and HYV Boro due to presence of submersible embankment, compartmental embankment, regulator and closure, which protect their crops from early flash flood. Hence, total annual crop production is about 4,934 tons with loss of 813 tons after interventions. Detailed estimation of crop production after interventions is presented in **Table 4.5**.

Table 4.5: Annual Crop Production in Dhaleswai River System under Post Project Situation

Crop name	Total crop area (ha)	Damage free area		Damaged area		Annual production (ton)	Production lost(ton)
		Area(ha)	Yield (ton/ha)	Area(ha)	Yield (ton/ha)		
B. Aman	54	46	2.0	8	1.2	102	6
Lt. Aman	357	286	2.3	71	1.0	729	93
HYV Aman	433	325	3.0	108	1.1	1,094	206
Hybrid Boro	65	45	5.5	19	1.8	285	72
HYV Boro	238	155	4.8	83	2.0	910	234
Wheat	54	46	2.2	8	1.1	110	9
Vegetables	76	64	25.0	11	8.0	1,702	193
Total	**1,278**	**246**	**-**	**111**	**-**	**4,934**	**813**

Source: CEGIS estimation based on field information, September; 2017

Impact

Additional 1,952 tons crop is being produced in Post Project situation. The crop production is increased due to the protection of flash flood which encourages the farmers for practicing high yielding variety instead of local variety. Detailed estimation of impact on crop production is presented in **Table 4.6**.

Table 4.6: Impact on Crop Production in Dhaleswai River System

Crop name	Pre-project Production(ton)	Post Project Production(ton)	Impact (Post Project-Pre Project)
B. Aus	211	-	-(211)
Aus	283	-	-(283)
B. Aman	219	102	-(117)
Lt. Aman	1,337	729	-(608)

Crop name	Pre-project Production(ton)	Post Project Production(ton)	Impact (Post Project-Pre Project)
HYV Aman	-	1,094	1,094
Hybrid Boro	-	285	285
HYV Boro	-	910	910
Wheat	-	110	110
Vegetables	932	1,702	771
Total	2,982	4,934	1,952

Source: CEGIS estimation based on field information, September; 2017

4.3. Crop Damage

Pre-project

Flash flood was the main cause of crop damage in pre-project situation. Before harvesting of Boro/Robi crops, water entered into the haor area and damaged the crops. So, farmer of this area suffered due to damaging of their crops in every year. Total crop damage in the project area was 533 tons annually. Detailed estimation of crop damage is presented in **Table 4.4**.

Post Project

Dhaleswai River is now protected from early flash flood by the project interventions which basically performed well up to 2012. After that, most of the year, flood water enters into the project area before harvesting of Boro crop (early to mid-March) due to low height of submersible embankment and malfunctioning of structures in Asam para and Sankibhanga Mouza.

Floodwater enters into the project area through the surrounding Dhaleswai River either by overtopping or by breaching the embankment at several locations. The height of embankment of the haor is low in comparison with the design level and more than 8 breaches are located in this embankment at Asam para and Sankibhanga Mouza. Every year BWDB closes the major breaches and entrances of the khal. The main reason for flooding in this haor over the years is that the rivers have silted up and their water flowing capacities are gradually reducing. The excessive sedimentation makes rivers incapable of holding and conveying floodwater, which creates excessive pressure on earthen embankment. Moreover, plant height of hybrid/HYV is less than local varieties and growing period of most of the Hybrid/HYV varieties are higher than local varieties except BRRI dhan28. So, flood water affects the whole crop area at a time. The annual crop damaged area was about 15% due to natural calamities (Hail storm, Heavy rainfall etc) and drainage congestion at before 2012 but now it increased to 24% due to non-functional condition of different structure, over flow of flash flood and siltation of rivers, Khals, and beels of the study area. The devastating floods of 2004 inundated the project area on the mid week of April. Local people reported, around 80% of Boro both HYV and local varieties were damaged by the devastated flood and late flood damaged the seedbed of T Aman and around 50% of the T Aman crop. B Aman crop were also fully damaged in this year due to sudden rise of the floodwater and wave action. In 2007, around 75% of Boro both HYV and local varieties were damaged by the devastated flood. But, this year (2017), around 100% of Boro crop areas are damaged at pre-mature stage. Most vulnerable mouzas such Asam para and Sankibhanga are identified in this respect. Total crop damage is recorded as 813 tons after interventions. Detailed estimation of crop damage after interventions is presented in **Table 4.5**.

Impact

The crop damage area has been increased from 20% to 24% after interventions, especially after 2012. Therefore, crop damage has been increased to 813 tons. This is happened due to the malfunctioning of the interventions and reduced water carrying as well as retention capacity of surrounding rivers, khals and beels. Detailed impact assessment on crop damage is presented in **Table 4.7**.

Table 4.7: Impact on Crop Damage in Dhaleswai River System

Crop name	Pre-project Production loss (ton)	Post Project Production loss (ton)	Impact (Post Project-Pre Project)
B. Aus	17		-17
Aus	43		-43
B. Aman	17	6	-10
Lt. Aman	249	93	-156
HYV Aman		206	206
Hybrid Boro		72	72
HYV Boro		234	234
Wheat		9	9
Vegetables	207	193	-14
Total	**533**	**813**	**280**

Source: CEGIS estimation based on field information, September; 2017

4.4. Irrigation

Pre-project

Before initiation of the project, only surface water was used for irrigating Local Boro crops. The local people normally transplanted this crop immediately after the floodwater recedes and the land is under shallow inundation. Local farmer reported that they stored water with help of bundh/dyke management and irrigated their crop with the help of flooded water in the low lying part of the Haor. They also used traditional modes like *Seuti, Don and Cone* for irrigating their crop from surrounding rivers, Beels and Khals during dry season. Prior to the implementation of the project, irrigation water was more available than the requirement of crops.

Post Project

After implementation of the project, the irrigation water demand has been increased due to cultivation of high water demanding HYV/Hybrid verity instead of Local verity. On the other hand, the availability of surface water is being reduced due to siltation of surrounding rivers, khals and beels of the project area. Therefore, the scarcity of irrigation water has been observed from early February to end of March in most of the year. In this time, Dhaleswari River is the main source of surface water irrigation. Mainly Low Lift Pumps (LLPs) is being used for lifting surface water instead of traditional mode. In addition, about 25% of crop area is being irrigated from groundwater by using Deep Tubewell (DTW).

Impact

There was deficit of irrigation water due to increase of water demand and decrease of water availability during dry season. The irrigation water demand has increased for cultivating high yielding crop variety. On the other hand, surface water irrigation availability has decreased due to siltation of rivers, khals and beels of the project area.

4.5. Agro-chemicals Use

Pre-project

Farmers of the project area cultivated Aman, Aus and vegetables in pre-project situation. They didn't apply agro-chemicals for crop cultivation. However, some farmers used inorganic fertilizer like mixed grass and rice straw in the crop field for the restoration of soil fertility.

Post Project

Generally, more agro-chemicals are required for cultivating Hybrid and HYV Boro crops. So, farmers applied more agro-chemicals for HYV Aman and HYV/Hybrid Boro crop cultivation. Total about 234.8 tons chemical fertilizers, 0.82 Kiloliter liquid and 1.94 tons granular/powder pesticides were used in the study area for crop cultivation per year. Detailed use of agro-chemicals under Post Project situation is presented in **Table 4.8**.

Table 4.8: Use of Agro-chemicals in Dhaleswai River System under Post Project Situation

Crop name	Fertilizer (Kg/ha)				Total (kg/ ha)	Pesticides	
	Urea	TSP	MP	Others		Liq. (ml/ha)	Gran. (Kg/ha)
B. Aman	50	0	0	0	50	200	0.5
Lt. Aman	80	15	15	0	110	500	1
HYV Aman	110	25	25	0	160	500	1
Hybrid Boro	180	80	65	0	325	1000	3
HYV Boro	150	70	60	0	280	1000	2.5
Wheat	120	80	50	0	250	600	2
Vegetables	150	60	80	0	290	1000	3

Source: CEGIS estimation based on field information, September; 2017

Impact

Use of agro-chemical has increased largely under Post Project situation compared to pre-project situation. Additional about 234.8 tons chemical fertilizers, 0.82 Kiloliter liquid and 1.94 tons granular/powder pesticides are used for crop cultivation in this area. Detailed impact on use of agro-chemical is presented in **Table 4.9**.

Table 4.9: Impact on Agro-chemicals in Dhaleswai River System

Crop Name	Pre-project			Post Project			Impact		
	Total Fertilizer (ton)	Pesticides		Total Fertilizer (ton)	Pesticides		Total Fertilizer (ton)	Pesticides	
		Liquid (Kilo Liter)	Powder/ Granular(ton)		Liquid (Kilo Liter)	Powder/ Granular(ton)		Liquid (Kilo Liter)	Powder/ Granular(ton)
B. Aus	0	0	0	0	0	0	0	0	0
Aus	0	0	0	0	0	0	0	0	0
B. Aman	0	0	0	2.7	0.01	0.03	2.71	0.01	0.03
Lt. Aman	0	0	0	39.3	0.18	0.36	39.32	0.18	0.36
HYV Aman	0	0	0	69.3	0.22	0.43	69.33	0.22	0.43
Hybrid Boro	0	0	0	21.1	0.06	0.19	21.12	0.06	0.19
HYV Boro	0	0	0	66.7	0.24	0.60	66.73	0.24	0.60
Wheat	0	0	0	13.5	0.03	0.11	13.54	0.03	0.11
Vegetables	0	0	0	22.0	0.08	0.23	21.99	0.08	0.23
Total	**0.00**	**0.00**	**0.00**	**234.8**	**0.82**	**1.94**	**234.75**	**0.82**	**1.94**

Source: CEGIS estimation based on field information, September; 2017

5. Livestock Resources

Livestock and poultry, being an essential element of integrated farming system, play an important role in the economy of the Haor area. Livestock provides significant draft power for cultivation, threshing and crushing of oil seeds; cow dung as a source of manure and fuel; a ready source of funds; and meat, milk and eggs for human consumption. A large number of livestock are reared in Haor areas but constrained by flash flood causing inundation of large areas during most of the time in the year. This area is famous for duck rearing due to availability of natural feed for ducks in natural large water bodies. All of livestock species suffer much due to shortage of feed, outbreak of waterborne diseases and inadequate shelter facilities. The livestock rearer in the Haor areas do not get fair price due to poor communication as well as lack of marketing facilities.

The indicator status of livestock has been selected for assessing the impact of the project. The status of livestock population data was collected from Livestock Census (1986), Agriculture census (1996 and 2008) of BBS. The status of livestock feed and fodder, diseases, marketing facilities information were gathered from stakeholders through Focus Group Discussion (FGD) and Key Informant Interview (KII).

5.1. Status of Livestock Population, Feed and Diseases

Pre-project

According to livestock census 1996, the livestock and poultry population in the project area were 1,450 cattle, 390 goats, 4,910 chicken and 1,670 ducks (Table 5.1). Before implementation of the project, the major feed available to ruminants was mostly crop residues (rice straw) supplemented with weeds from cultivated fields. They are to depend on naturally grown grasses in Kandas and alongside roads and embankments. Most of the year before implementation of the project, the crops were to damage by early flash flood. As a result, shortage of feed from crop residues, reduction of grazing facilities seriously affect livestock rearing. That time, the small holders were to depend on water hyacinth and other aquatic plant for their cattle. The major poultry feeds were rice bran, broken rice, kitchen wastes like rice, rice-gruel, vegetables, fish wastes etc. In addition, the duck usually scavenges in the nearby waterbodies like haor, beel, khal, river or any other low lying areas; mainly eat various types of aquatic insects, small fish, shell or snails. Major livestock and poultry diseases were Gola Fula (Haemorragic Septicemia), Foot and Mouth Diseases (FMD), Pox and Cholera, Duck Cholera, Fowl Pox and Fowl Cholera etc. The most vulnerable period was between July to November for spreading diseases to livestock and poultry populations. Mortality rate of the livestock/poultry was higher due to poor shelter condition and they lived in unhygienic condition. Marketing facilities was not in good condition and price was also low due to less demand of their products and by products. Producer consumed their products at family level and additional products were sold at local village market.

Table 5.1: Status of Livestock/Poultry in Dhaleswai River System

Livestock/ Poultry Category	Pre-project		Post Project		Impact
	No of Households having Livetock	Total No of Livestock	No of Households having Livetock	Total No of Livestock	Number of Livestock Population
Cattle	370	1,450	520	2,020	570
Goat	140	390	210	590	200
Chicken	600	4,910	790	5,810	900
Duck	310	1,670	330	1,910	240

Source: CEGIS estimation based on agriculture census (1996 and 2008) and field information (July 2017)

Post Project

According to agriculture census 2008, the livestock and poultry population in the project area are 2,020 cattle, 590 goats, 5,810 chicken and 1,910 ducks (Table 5.1). After implementation of the project, crop is protected from early flash flood. As a result, the feed availability of livestock is increased due to increase of crop production. However, some of the year, the crops were damaged by early flash flood. In that year, the small holders were depending on water hyacinth and other aquatic plant for their cattle. The poultry feeds are same as in Pre Project situation. On the other hand, more or less similar diseases are found in Post Project situation. The mortality rate of the livestock/poultry became negligible during the project period, due to extension works at farmers' level such as immunization and insemination program by Department of Livestock (DLS). Marketing facilities during dry season also improved due to improvement of the communication system by constructing the submersible embankments. Therefore, market prices are increased due to high demand of products and by products.

Impact

From 1996 to 2008, about 570 cattle, 200 goats, 900 chicken and 240 ducks have increased due to the reduction of flood vulnerability, improvement of marketing facilities and strengthening of livestock extension services. Details about impact on livestock are presented in **Table 5.1**.

6. Fisheries Resources

Diversified fisheries resources are present in the study area. Seasonal and perennial beel, connecting khals, floodplain and some fish ponds are present in the study area. The khals are playing a vital role for fish migration. The study area is bounded by rivers namely the Dauki river in west, Goyain River in South. Naljuri khal is (adjacent) in east side embankment. This is flash flood area. The study area inundated by flash flood or by rain water or by the river water. The rain water come directly in to the area through spill over the submersible embankment and inungate the area. The river water enter in the study area through Naljuri khal. The khal also use as drainage khal of the area in post monsoon period. The river water enter the Hidoli deel area through Satsori khal. Two vent regulator is present at the khal but not enough to serve the purpose. The Nalijuri khal is perennial in nature and sufficient water is present in dry season.

These khals are act as fish migratory route of study area and maintain the fish productivity of the area. The khals in the area are facilitate the fish migration from river to beel and floodplain and support in capture fish production. In post monsoon the floodplains are use as crop field. Besides these fish ponds are use as fish culture and contributing partially in fish production. During field visit, discuss with the local peoples and they informed that the flood occurs due to upstream rain and enter the water into the study area after 3 to 4 hours. Or the river water enters the study area through Satsori khal and inundate the study area. The water entering system in the study was almost same in pre Intervention period. The study area is bounded by embankment that also use as local road.

6.1. Habitat Area

Dhaleswai is the main river in the study area. The major beel are namely Hidoli Beel, Bamon Beel / Study, Kakai beel. The beels are seasonal and perennial in nature. The major khals are Cheilakhali khal and *Naljuri Khal (adjacent to east side embankment) and* Boali khal*.* These khals are the major fish migratory route in the study area. In dry season the depth of water in khals is enough especially in *Naljuri Khal* and sufficient for fish sheltering place.

In dry season the study area is used as crop field except the perennial beel area. And in monsoon the area is inundate by water and used as floodplain. Water stay about 3 to 4 month and the floodplain uses as breeding and feeding habitat for fish. In the perennial beel some water hyacinth is present that are used as sheltering place for fish and other aquatic animals especially in post monsoon period.

Pre Project

Fish habitat of the study area was 1052 ha in pre Intervention period. Of which capture fish habitat 1047 and fish pond 5 ha. The overall scenario of fish habitat was comparatively good. And the connectivity of khals with beel, floodplain and river was smooth.

Post Project

Post Intervention the total fish habitat is 1022 ha. Of which capture fish habitat 1012 and fish pond 10 ha. The perennial beel and floodplain are silted up partially due to flash flood. The connecting khals are silted up and loss the water holding capacity in dry season. Photo of fish habitat of the study area is given below **Figure 6.1**.


Figure 6.1: Fish Habitat of Dhaleswai Study Area

Table 6.1: Breakdown of Fish Habitat Area by Habitat Type

Sl.	Fishery Category	Habitat type	Area (Ha)		Impact (Habitat Change in Ha)
			Pre Intervention	Post Intervention	
1	Capture	Perennial Beel	92	11	-81
		Khal	22	26	+4
		Floodplain	931	975	+44
		Baor	2	0	**-2**
		Sub Total	***1047***	***1012***	*-35*
2	Culture	Culture pond	1	5	+4
		Seasonal pond	4	5	+1
		Sub Total	***5***	***10***	***+5***
		Grand Total	**1052**	**1022**	**-30**

Source: Fish habitat assessment based on field findings and image based landuse data,1989 & 2015.

Impact

Decrease of fish habitat is 30 ha in the post Intervention period, which is decrease about 3% of pre Intervention condition. Breakdown of fish habitat is given in the following **Table 6.1**.

6.2. Habitat Condition

Habitat condition of the study area is good and productive. Perennial and seasonal beel present. But at present the scenario of fish habitat is changing because of incremental boro cultivation.

Pre Project

Fish habitat condition and water quality was good in pre intervention period. The farmer cultivates the local variety and use of agrochemicals and pesticides and fertilizer use was limited.

Post Project

Boro cultivation is increasing day by day and increasing the use of agrochemicals, pesticides and fertilizer. So habitat condition and water quality is degrading due to incremental use of agrochemicals, pesticides and fertilizer in boro field. The water in the study are also polluted by wastages from homestead, market and other anthropogenic activities and decrease the fish habitat quality.

Impact

Fish habitat condition and water quality is degrading by incremental use of agrochemicals, pesticides and fertilizer in boro field and wastage from homestead and markets.

6.3. Fish Diversity

Pre Project

The available fish species are about 80 as reported by the local fishers and aged peoples in the study area. The available fishes are tengra, taki, puti, kholisha, kakila, boal, potca, guchi baim, tara baim, mola, chela, gutum, magur, baila, rui, catla, mrigal, kalibaus, ayre, shing, koi, pabda, chola puti, tit puti, puti, gulsha, deshi sarputi, foli, chapila, darkina, chital, gura icha, chang/okol, shol etc. Abundance of some fishes was comparatively good in the study.

Post Project

The number of fish species is almost same in compare to pre intervention situation. The team members discuss with the local peoples and fishers to know the previous situation of fish species. They informed that at present the number of fish species are almost same as before. But some of the fish species which was unavailable few years ago, at present these species are observing in some extent like deshi sarputi, ghonia, mani, pabda, boro baim, napit koi etc.

Impact

The number of fish species are same. But some fish species are now available in some extent. These fish species are ghonia, lal chanda, lamba chanda, deshi sarputi, pabda, baro baim, kalibaus, napit koi etc. And fish richness has some changes.

6.4. Fish Migration

Pre Project

The fishes move and migrate easily from one place to another place without any barrier. The small fishes use the shallow depth for breeding and feeding purpose. Overall fish migration was smooth.

Post Project

Fish migration is disturbing because of embankment and regulator and siltation.

Impact

Disturbing of fish migration and delayed fish breeding especially the small fishes in some extent in the study area.

6.5. Fish Production Assessment

Pre Project

Fish production was about 124 Metric Ton (MT) per year. Of which from capture habitat was about 122 MT and from culture habitat was about 2 MT per year.

Post Project

Total fish production is about 279 MT per year. Of which from capture habitat is about 259 MT and from culture habitat is about 20 MT.

Impact

Increase of fish production is about 155 MT per year. The incremental fish production may cause due to increasing of fishing activities, introducing of beel fisheries, beel nursery and commercialization of fishing, stocking of culture species in the beel etc. Fish production from pre intervention and post intervention are given in the following **Table 6.2**.

Table 6.2: Breakdown of Fish Production by Habitat Type

Sl.	Category	Habitat type	Production (MT)		Impact (Production Change in MT
			Pre Project	Post Project	
1	Capture	Perennial Beels	49	103	+54
		River and Khal	3	5	+2
		Floodplain	98	421	+323
		Sub Total	***150***	***529***	***+379***
2	Culture	Culture habitat	1	220	+219
		Sub Total	***1***	***220***	***+219***
		Grand Total	**151**	**749**	**+598**

Source: Fish production assessment based on field findings and FRSS data 1989 and 2015.

6.6. Fishing Appliances

Pre Project

Types of fishing gears namely current jal thela jal, ber jal, puti jal, khora, borshi, Gui (type of trap used to catch small fishes) was used to catch the fishes from the study area. The mesh size of net was above 2-3 cm (±1 inch) that use to catch the fishes. The net was fish friendly and protect the small fishes during fishing.

Post Project

The fishing gears are almost same in pre intervention period. At present the fishers are using some new nets and traps like kona jal / moshari jal (small mesh size net below 0.5 cm) damaging the fish fry as well as habitat quality. Some cases the beel owners catch the fish by dewatering in post monsoon period.

Fishing by thela jal

Fishing by Borshi

Figure 6.2 Fishing by Different Types of Gears of Dhaleswai Study Area

Impact

Excessive use of moshari (small mesh size net) jal is damaging the fish fry as well as habitat quality. Some cases the beel owner catch the fish through dewatering of some beel in post monsoon period that also destroying the fish habitat.

6.7. Fishers Livelihood

In the study area Muslim and Hindu fishers are present. The professional, part time and subsistence fishers are present. The professional fishers used to catch fish in the study area and after that they catch fish in adjacent river. The part time fisher catch fish after inundation of study area in the (Bangla) month of Boishak / Jaistho to Ashin / Kartic (Late April to October). The part time fishers engage with agriculture activities after fishing. The subsistence fisher catch fish only for own consumption.

Pre Project

Most of the cases the Hindu fishers was involve with fishing. The numbers of professional fishers were limited in pre intervention period. The Muslim fishers was limited. The number of subsistence fishers was present but little bit and the part time fishers was almost absent.

Post Project

In post intervention numbers of Hindu and Muslim fishers has increased. Day by day number of part time fishers are increasing rapidly. The part time fishers are mostly Muslim. Beside these few numbers of peoples are involved for their livelihood as fish retailer, fish aratder, ice producer, fish labor, transport worker etc.

Impact

The number of fishers increased in post Intervention period. The number of professional fishers increased partially but increase the number of part time fishers rapidly. Few numbers of peoples are involving for their livelihood as fish retailer, fish aratder, ice producer, fish labor, transport worker etc.

6.8. Fisheries Management

Pre Project

The fisher catch fish all the study area during monsoon and post monsoon period without any limitation. The fishing practice was almost smooth. Even some of the perennial water bodies was kept as safeguard for the brood fish for next year breeding. The professional fisher never catch fish by de-watering. No leasing system was present in the study area.

Post Project

During monsoon there is no restriction to catch fish in study area. But in post monsoon the fishing is restricted in privately own beel area. Some cases the privately own beels are protect through guarding from the month of Ashin (Bangla) to onward up to fishing. So fishing access is limited in privately own beel area.

Impact

The private beel owners protect the fishing through guarding. So the professional fishers are not getting any benefit from these beels. The professional fishers are losing their fishing rights.

7. Ecosystem

The study area supports terrestrial as well as aquatic ecosystems like settlements, cropfields, wide seasonal floodplains and perennial waterbodies. Each of the ecosystems possesses different floral and faunal compositions.

7.1. Terrestrial Flora

Pre Project

Terrestrial flora of the study area was mainly centered on homestead platforms round the year and vast area of cropfields during dry season. Vegetation patterns of homesteads vary according to land types. Foothills area at northern portion of this study area were dominated with Bamboo grooves and other terrestrial trees like Rhyna *(Aponomyxis polystachya),* Jackfruit *(Artocarpus heterophyllus),* Coconut *(Cocos nucifera)* etc. Number of naturally grown species were higher than human planted species. Naturally grown species were abundant at each of the homesteads backyards and fallow areas. Homesteads of Nayagang Para, Asam Para, Baurbhog study area are the lower portions that located at southern parts were mostly dominated with flood tolerant plant species like Pitali, Hizol and Baroon. Very few numbers of economic plants were observed in this area as was prone to seasonal flood in each year.

Cropfields are the location of seasonally grown terrestrial flora were vegetated with numerous herbs and shrubs. Hizol tree was remarkably followed all over the cropfield ridges (*'Ails').* There were vast scope of grow reedland grasses like Binna, Chailla within the cropped area.

Post Project

The situation has slightly changed in the case of cropfield within southern part of the study area. Extension of agricultural area have reduced the naturally grown species within the cropfield. According to local people, Hizol trees on the cropfield ridges have drastically reduced from last few decades due to felling by the local people for their interest of more crop production. Homestead vegetation have enriched with economic plants for people tend to plantation nowadays. Natural vegetation of foothill portions at Chilakhel, Muslim Nagar area have decreased due to expansion of human habitat over the time. However, among the indicator species, status of Pitali and Baroon are unchanged and commonly found all over the area.

Impact

There is no direct impact on terrestrial flora due to implementation of interventions over the time in this study area. But agricultural extension and human habitation caused damages of natural vegetation which refer the responsibility to interventions in some extents for facilitation of more crop production. The specific impact on flora has been represented below in **Table 7.1**.

Figure 7.1: Terrestrial Vegetation at Homestead Ridges of the Study Area

Table 7.1: Changes of Status of Indicator Species

Indicator Species	Pre Project	Post Project	Cause of status change	Type of Intervention that caused the change (If Yes)
Pitali/Mera	Common	Common	-	-
Hizol	Common	Rare	Agricultural expansion	Indirectly sluices
Koroch	Occasional	Occasional	-	-
Barun	Common	Common	-	
Dhol Kolmi	Occasional	Occasional	-	

7.2. Terrestrial Fauna

Pre Project

Natural vegetation of foothills area and reedlands was support good number of terrestrial fauna. Among this, Bengal fox, fishing cat, Brahminy kite and Black Kite were abundantly reported by the local villagers. High density of foothill vegetation was favoring various avifaunas as their resting and nesting place. Pallas's Fish Eagle was found in this study area that create their nest on Hizol trees along cropfields and fallow area. Long trees on settlement area also support this globally endangered avifauna. Cricket Frog, Rat Snake were also abundant in solitaire place of homestead ridges and fallow lands. During dry season, cropfields were act as the grazing habitats for many local birds.

Post Project

Status of indicator faunal species have been changed due to changes of landuse as well as vegetation composition of the upland areas (homesteads, cropfields, foothills area and fallow Lands). Expansion of human settlement reduced natural vegetation at upland area which increase the habitat shortage for Foxes, Jackal and snakes. Application of insecticides threatened to amphibian species like Bull frog and Cricket Frog. Most of the local avifauna have taken their shelter at homestead area for conversion of fallow land into cropfield and Increase practice of plantation on homestead area.

Impact

Statuses of terrestrial fauna have changed with project situation for changes of landuse as well as vegetation composition. But there is no direct influence of interventions in this regards. A specific status of the terrestrial fauna is presented in **Table 7.2**.

Table 7.2: Intervention Impact on Terrestrial Fauna of the Study Area

Indicator Species	Pre Project	Post Project	Cause of status change	Type of Intervention that caused the change (If Yes)
Pallas's Fish Eagle	Common	Not found	Expansion of human settlement and cutting of tall trees	-
Brahminy Kite	Very Common	Common	Disturbance by human, damages of wetland trees inside cropfields	-
Vulture	Not found	Not found	-	-
Fishing Cat	Common	Rare	Destruction of natural vegetation for settlement expansion	-
Bengal Fox	Common	Rare	Destruction of natural vegetation for settlement and cropfield expansion	-
Rat Snake	Common	Occasional	Application of insecticides	-

7.3. Aquatic Flora

Pre Project

Seasonal floodplains, beel area and reedland ridges are the major habitats for aquatic flora. Shallow portions of seasonal floodplains showed luxurious growths of water lilies. Dhol Kolmi *(Ipomoea fistulosa)* was growing abundantly within the marshy ridges of cropfields and fallow lands of the study area.

Post Project

After implementation of interventions, agricultural practice has been boosted up within the area. Local people tend to expand their crop area even inside the perineal beel ridges and on more fallow lands. These activities have squeezed the habitat for growing aquatic vegetation. Over fishing in floodplains with '*Bain Jaa*l' (fine meshed fishing net) destroyed a large amount of aquatic vegetation. These also interrupt germination of hydrophytes like water lily, Singara (*Trapa bipinosa) and* Makhna (*Euryale ferox*) and many species of submerged plants.


Figure 7.2: View of Floral Composition of Aquatic Vegetation within the Study Area

Impact

Abundance and population of aquatic flora have been reduced from the study area due to expansion of agricultural practice and overfishing. Interventions are not responsible in this change. A detail specific status of the aquatic flora is presented in **Table 7.3**.

Table 7.3: Status of Aquatic Flora of the Study Area

Indicator Species	Pre Project	Post Project	Cause of status change	Type of Intervention that caused the change (If Yes)
Kochuripana	Occasional	Occasional	Not applicable	-
Shapla	Very Common	Common	Agricultural expansion, fishing activities	Not applicable
Makhna	Common	Disappeared	Agricultural expansion, Over exploitation	Not applicable
Singara	Common	Occasional	Fishing activities	Not applicable
Chhaila Grass	Occasional	Decreasing	Over exploitation	Agricultural extension and herbicide use

7.4. Aquatic Fauna

Pre Project

Fishes were the major aquatic faunal group that was abundantly grown all over the aquatic portions of the study area. Aquatic vegetation was provided well habitats for numerous water dependent birds (i.e. Little Cormorant, Little Egret, Great Egret, Cattle Egret and Pond Heron) all over the year. *Brahmon Beel* at northern portions of the Study area was feeding place for many migratory birds. Amphibian and reptiles population were well along the cropfields, ditches and beel areas. Eurasian Otter (Lutra lutra) was reported occasionally in large beels and even in old homestead ponds.

Post Project

With the growth of human population, the demand of food crops has increased. As a result, agriculture practices have been boosted up within more areas even in beel areas or naturally grown aquatic vegetation site. Destruction of aquatic vegetation caused loss of habitat suitability for most of the aquatic fauna. Water dependent birds as well as migratory birds faced feed shortage due to hamper hydrophytes growing inside beel area. Otter population has drastically down for damages of solitary ditches and beels inside the depressed parts of the study area. Application of insecticides has badly impacted to Indian Bull Frog and snakes. Duck rearing and fishing with fine mesh nets caused diminution of freshwater snail population. Due to the implementation of interventions throughout the study area, it triggers the diminishing of their population as well as diversity for decades.

Impact

Destruction of aquatic vegetation, overfishing, application of insecticide resulted aquatic habitat degradation which caused reduction of population of aquatic fauna. A detail impact of the interventions has been provided below in **Table 7.4**.

Table 7.4: Aquatic Fauna Status of the Study Area

Indicator Species	Pre Project	Pro Project	Cause of status change	Type of Intervention that caused the change (If Yes)
Indian Bullfrog	Very Common	Common	Agricultural extension	Embankment
Monocellate Cobra	Common	Rare	Use of pesticides, hunting	Not applicable
Indian Roofed Turtle	Not found	Not found	Hunting	Not applicable
Migratory Birds/Waterbirds	Very Common	Common	Agricultural extension	Not applicable
Eurasian Otter	Common	Occasional	Habitat destruction	Not applicable

7.5. Swamp Forest and Reeds

Pre Project

There was no swamp forest located within this study area before implementation of the interventions. But this study area possessed some reedbeds at the nearer swamp lands of Dhaleswai River surrounds. The lands were mainly dominated with tall grasses and attain swamp character whole of the year. This lands have elevation with gentle slopes and deeply flooded in monsoon which locally called “Pajubon”. Common vegetation composition is *Phragmites karka, Saccharum soontaneum Vetiveria zizanioides, Sclerostachya fusca* and *Arundo donax* within the grasses. *Ficus heterophylla, Asparagus racemosus, Lipia iavanica* and *Rosa involucrata* are the dominant woody shrubs. Within this study area, the reedbeds were out of agricultural practices in most of the locations.

Post Project

Reedlands have been converted to cropfield with expansion of agricultural practices. Now there have some traces of reedland vegetation surrounded open areas of study area. However, deterioration of reedland ecosystem squeeze the habitat area and negatively impacted on Wildlife like numerous local birds, fishing cat, jackal, snakes etc.

Figure 7.3: A part of Reedland Near Muslim Nagar Village Mostly Now Are Converted to Cropfield (Picture Taken September 2017)

Impact

Agricultural expansion caused conversion of reedland to cropfield and facilitation of crop cultivation by implementing interventions is indirectly responsible in this regards.

7.6. Ecosystem Goods and services

Pre Project

Major ecosystem goods are fertilizer, food, medicine, energy, fiber, construction and craft material. On the other hand, the ecosystem services have been divided into four categories on the basis of their nature of functions and they are provisioning, regulating, supporting and cultural services. In this stage, the goods and services had not interrupted by any interventions and these are improved naturally. Food, medicinal plants and genetic resources of the flora and fauna are considering the **provisioning services** in this area had been standard before implementation of the interventions. There were vast **Regulating services** such as climatic condition was good because of vast coverage of natural vegetation. Wetlands were functioning well due to possess its natural characteristics without any intervention.

Post Project

Ecosystem services have been changed with changing of functionality of wetlands as this area is mostly depend on wetland ecosystems. The provisioning services as well as food production have boosted up in the case of cultivated varieties. Population growth is mainly responsible in this case. But food production from natural vegetation have been decreased day by day due to destroyed aquatic vegetation for overfishing and crop cultivation. Destruction of reed land vegetation caused thatch and fuelwood shortage to the local people. The **regulating services** also interrupted for same causes.

Impact

Ecosystem services have been changed over the time for changes of landuse as well as increase human population.

8. Socio-economic Conditions

8.1. Introduction

This study was conducted to understand the socio-economic condition and social impact due to the project intervention. The study findings of this project would be related to assess the project impact (before and after project) in relation to environmental policies, environmental management systems and environmental management practices on the basis of the determined criteria of the implemented project. The socio–economic scenario was explored to understand people's socioeconomic condition in both before and after project condition using both primary and secondary data considering the objectives of the study. The primary data has been collected using different social methods (i.e. informal interview, Focused Group Discussion (FGD), observation and Group Discussion) and secondary data used from the source of Population Census 2001 (Before project) and Population and housing census 2011 (after project).

8.2. Administrative Bounding of this Study Area

Administrative boundary of the Dhaleswai Haor basin is defined by the project boundary itself located in Sylhet district under the Gowainghat thana. The 10 mouzas of Purba Jaflong union are covered under this study.

8.3. Population

Following **Table 8.1** shows the Mouza wise population of this study area based on Bangladesh population and housing census 2001, 2011 and on projected population for 2017.

The Population and housing census data 2001 shows that there are 19,430 people live in this Dhaleswai Hoar project. The number of population was increased as 32,265 in the 2011. Withpopulation projection, it is found that presently about 35,010 people are living in this Haor region.

Table 8.1: Total Population of the Study Area

Total Population in 2001	Total Population in 2011	Projected Population in 2017
19,430	32,265	35,010

Source: Bangladesh Population and Housing Census 1991 & 2011.

8.4. Housing Condition

Pre Project

Housing condition of this study area was predominantly Kutcha which was 58.60 % of total households. Besides, 8.04 % and 18.36 % households lived in semi pucka respectively, and only 15.00% lived in Pucka houses. (Population census 1991)

Post Project

With the period of time, the river bank protection works of the project tempted people to come and build houses at this study area. Besides, people got opportunities to go abroad and engage themselves in income generating activities. In this way, the pattern of housing condition has changed. The change brought about 75% of total households households to live in semi pucka categories whereas only 10% households are in kutcha, 12% households are in pucka and rest of the proportion is in Jhupri categories (Population and Housing Census 2011). People's tendency to build Pucka building is increasing with the rise of income opportunity and overall socio-economic development in this study area.

Impact

River bank erosion was a major threat to the inhabitants of this haor before the project construction. Safety and security provided by the river bank protection works have been the iconic benefit for the project population. Houses were mostly vulnerable to erosion and household assets were subject to damage or destruction every year due to erosion and floods. Protection or repair of house was costly, rendering poor victims to borrow costly money from money lenders.

After project construction (submergible embankments and erosion protection measures), security from erosion and floods has freed the population from threat of erosion, causing them to build better houses with permanent facilities. Moreover, people from outside also migrate into the area for housing and living. The impact has been positive in this regard.

8.5. Livelihood Status

Pre Project

In Pre Project, about 21 % households depended on agriculture which was the main source of household income. Besides, 9% fishery, cropping, livestock and 10.39% as agricultural labor. On the other hand, other sources of income were non agricultural labor (5.32%), business (18.72%), employment (14.56%) remittance (7%) and rest of the source (14.01%) of household income were industry, transport and communication, rent and religious service.

Post Project

After the project intervention, agricultural production has increased and it project is their main source (23%) of household income in this project The income opportunity based on fishing has declined and only some people from fishing community have got access to work as a seasonal labor. Due to existing leasing arrangements, haor fishery resources are often controlled by local elites resulting in highly restricted access to open water fisheries by the poor. The flash floods have impacted on livelihood security and employment opportunities. Some areas of this Haor have been facing this problem acutely compelling the victims to accept alternative livelihood options. The options to work in the agricultural field is declining, as a result, a portion of agricultural labors are motivated to do alternative options like stone breaking, auto driving, industrial labor, boat laborer etc. With the period of time people's engagement on business have increased. It is learnt from KII and open discussions that about 35% people are involved in business (i.e. stone business) due to the development of communication and infrastructure at Tamabil Land Port.

Impact

The income opportunity based on fishing had been declined and only some people from fishing community got access only to do work as a seasonal labor in this particular area. Due to leasing arrangements which are often controlled by local elites resulting in highly restricted access to open water fisheries by the poor. People face problems and agricultural damage tended them to search alternative livelihood options. The options to do work in the agricultural field is declining, as a result, agricultural labors are motivated to do alternative options like stone breaking, auto driving, industrial labor, boat laborer etc.

Furthermore, some people (10%)1 from Dhaleswai Haorbasin go to Dhaka, Chittagong and sylhet to do different sorts of work to keep their income and livelihood options. People who have the affordability are going abroad (10-12%)[2] to generate income opportunities involving different sorts of works.

8.6. Income

8.6.1. Agriculture Based Income

Pre Project

Before intervention, the livelihood opportunities for households at the Dhaleswai Haor basin were limited and highly seasonal and associated with the single annual rice cropping cycle. Fishing was traditionally an important occupation which was considered as sources of livelihood options at this Dhaleswai basin. The incidence of livestock husbandry as a livelihood activity in the Haor region was also prominent as their tertiary source of income before intervention. It was found that the total income from the agricultural production was 669.98 lakh3 whereas people mostly used to grow B. Aus, Aus, B. Aman, Lt. Aman and vegetables.

Post Project

After project intervention, the income opportunity based on agriculture increased and people got chance to grow more paddy and recruit local labor, generating extra income opportunities for the wage earning households. People who have more land can grow more.

Based on current production rate it has been found that the income based on agriculture is near about BDT1069.18 lakhs. Farmers grow B. Aman, Lt. Aman, HYV Aman, Hybrid Boro, HYV Boro, Wheat and vegetables[4]

The production and income from agriculture have increased with project over that without project. Autonomous development in general due to practice of high yielding varieties has, of course, an influence in this increase but the project infrastructures have facilitated project farmers to seek more production by growing HYV Aman, Hybrid Boro and HYV Boro, protected from flash floods.

8.6.2. Wage-Base Income

Pre Project

Before the project, total net agricultural land was about 1201 hectare and the net demand for agricultural labor was 130 per hectare. The net income based on agricultural wage labor was roughly BDT645.90 lakh.

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[2] Field Data,2017 through FGD, Informal interview

[3] Field Data 2017

[4] Field Data based on KII, FGD and Observation

Post Project

After project, the net cultivable land increased marginally from 1201 to 1278 but the net demand for agricultural labor decreased due to the increase of modern technological innovation (i.e. Tructor, swallow Pump, Weedicides etc**)** in agricultural production. Though the net labor demand is decreased during the after project but the net income was increased 645.90 to 712.72 lakh due to the increased net cultivable land.

Impact

The agricultural production base income was increased from BDT 669.98 lakh to BDT1069.18 lakh. People's tendency to seek more production tended them to grow more agricultural production through HYV Aman, Hybrid Boro and HYV Boro when the embankments took a lead to protect the early flash flood at this Dhaleswai Haor basin. The wage base income was increased 645.90 to 712.72 lakh based on increased cultivable land and current wage rate (400 taka daily).

8.7. Land Price

Pre Project

Land price in this Haor was minimal before project and people were not interested to buy land due to regular flash flood and crops damage. The pre-project price of agricultural land was BDT30, 000 to 70,000 Tk per keyar[5] and that of homestead land was BDT60,000-100,000.

Post Project

After the project implementation, the land price started increasing due to the increased productivity of this land and protection of land from river bank erosion. Though here has an impact of natural flow of development and increased inflation rate, but people's interest to buy those lands is acknowledgeable after the time of project intervention. Presently, the price of agricultural land is around BDT1.0 lakh to BDT 4.0 lakh according to its productivity, whereas the price of homestead land is around BDT 5.0 to 8.0 lakh. Based on local people's statement, it has been understood that the value of land is increasing with the development of business opportunity and overall rural infrastructural development in this area.

Impact

Presently, the price of agricultural land is learnt to be around BDT 1.0 lakh to BDT 4.0 lakh whereas the price of homestead land is about BDT 5.0 to BDT 8.0 lakh. Local people opine that the value of land has increased primarily due to the project construction and it is further increasing with the development of business opportunity.

8.8. Drinking Water and Sanitation

Pre Project

The Haor region is characterized by low levels of access to improved sanitation facilities (i.e. latrines) as compared with other parts of Bangladesh. This pattern reflects the difficulty for the maintenance of sanitation infrastructure due to the erosion and the increasing population

[5] 1 Keyar = 33 decimals

densities. Despite the existence of tube wells in the region, many households (20.1%)[6] still collect water for domestic use from open water bodies (the haors and beels), which sources are often contaminated with pathogens. Problems of water and sanitation associated with poor hygienic behaviors often aggravate during the period of seasonal flooding, resulting in the high incidence of water-borne diseases in the Haor region. This is in turn associated with poor nutrition and health outcomes for mothers and children under five years of age.

Post Project

During the project intervention, most of the households (42.17%) drink tube well water, 1.14% drink tap water, 37.77% drink from river or pond water and rest of the households use other sources of drinking water. On the other hand, 18.11% households had sanitary latrine, 57.25%households had non-sanitary latrine and 24.89 % had no sanitary latrines. (Population Census; 1991).

Impact

After the project, the protection from the riverbank erosion tended them to build their houses which have increased over the period of time. Simultaneously, the use of drinking water from the source of tube well increased but the tendency to use open water still is in a considerable state. About 50 % households use river, pond and canal water to perform their WASH activities. Unavailability of ground water has compelled these people to use open water source, irrespective of its quality in this study area.

The tendency to build pucka houses and awareness due to different Govt and NGOs program, the tendency to use sanitary latrine has increased and played important role in improving their overall sanitation condition in this study area. About 30.73% households have sanitary latrines and 65.38 % households have non -sanitary latrines. Though the tendency to use open land for defecation has declined but still 3.89 % households have such tendency.

8.9. Road and Transportation

Pre Project

Before project, people faced problems to move due to the poor road and transportation facilities. People mostly used boat during the rainy season and used to go on foot during the dry season.

Post Project

After the project intervention, students started to use the embankment as their way to go to school and other people used it as road to go to bazaars and health centers and other desired places. Presently, different types of vehicles like auto rickshaw, easy bike, bikes and rickshaw move along the embankment for transportation of human beings and goods.

[6] Field Data, 2017

8.10. Accessibility in Health and Educational Institution

Pre Project

Before project, there was a community clinic in this study area. It is about 2.0 km. from the locality where people used to go for primary treatment. The Upazilla health center is located at the Goainghat Sadar (9 km away from the study area) where people go for their health care and for treating major health related problems. For local education, there were 14 primary schools, 3 high schools and a Madrasaha at varying distance where the students got their education.

Post Project

There is no change in the number of primary schools so far, but one high school has been added during the project. People still use the same health facilities as before the project. Only the use of embankment as road adds value to their utilities in terms of accessibility and time saving compared to before the project situation.

Impact

With the establishment of embankments local people, school going children, pedestrian, women and other people got the way easy by the use of this embankment's alignment (*Ayle*) especially in the dry season. Presently, when some of the locations of the embankments became damaged, people's way to reach to the schools and health institutions were being hampered in which people of the Dhaleswai haor basin suffer mostly for a certain time being. The risk of damage to their housing and property, and the particular constraints imposed by flash flood on women and girls' access to basic services of healthcare and education.

8.11. Labor and Seasonal Migration

Pre Project

There has been a strategic shift in labour demand after the project operation compared to the situation before. Intensive culture of high yielding and hybrid paddy varieties required more labour than before in land preparation, planting, applying fertilizers, pesticides, insecticides and in harvesting. Culture of local Boro paddy actually did not require so much except only for crisis harvesting during sudden overflowing of paddy fields by flash flood water.

Post Project

As for seasonal migration of labour, people from different regions used to come to join as work force for crop harvesting and fishing labors in this project area before project operation. Due to the facilities for stone business and stone collection labour selling opportunities, in-migration of people from different regions is happening.

Furthermore, during last ten years people have been facing regular damage due to flood and water logging. People dependent on agriculture are being forced to change their occupation.

Impact

The options to do work in the agricultural field is declining, as a result, agricultural labors are motivated to do alternative options like stone breaking, auto driving, industrial labor, boat laborer etc. In addition, some people (10%)[7] from this study area go to Dhaka, Chittagong and sylhet to do different sorts of work to find income opportunities. People who have the affordability are going abroad to generate income opportunities involving different sorts of works.

[7] Source: Field Data, 2017

9. Summary of Impacts

9.1. Summary of Impacts (Key Impacts, Try to Quantification)

Indicators	Pre Project	Post Project	Impact
Water Resources			
Flooding situation	The project area was inundated frequently by flash flood during mid April and at times in mid March.	After implementation of submersible embankment and other structures by BWDB in 2005-2006, entrance of flash flood into the haor got delayed by 15-20 days.	Risk of entrance of flash flood has reduced.
Drainage condition	Most of the flood water could smoothly be drained out to the peripheral rivers as the area was totally open. Most of the haor area got dried up at the end of November.	Drainage of flood water has been impeded due to interventions. Most of the haor area is drained by the first week of December.	The drainage of the haor has deteriorated a little bit. It got delayed by 15-20days than the pre-project condition. Conflict has arisen between the fishers and the farmer's interms of public cut. The farmers cuts the embankment for quick drainage to undertake cultivation but fishers want to keep water to increase fish production.
Sedimentation and siltation	The sediment carried by the flash flood got deposited both in the rivers and haor area. Hence, sedimentation was not that much problem before implementation of the interventions. As per people's opinion every year about 6-8cm in rivers and 4-5cm in khals and beels siltation occurred in the project area.	Sedimentation has taken place in the river and khals over the years. As a result, the bed level of the rivers and khals has risen and conveyance capacity has also been reduced Presently, about 12-20 cm in the rivers and about 5-7 cm in khals as well as beels every year.	Siltation has increased in both the peripheral rivers, internal rivers and khals also. Due to heavy siltation, the alignment of Dauki River is shifting towards the Ashampara village and causing breach of village road cum embankment.
Navigation	There was navigational connectivity between the haor and the peripheral rivers throughout the year. Movement of a number of large vessels used to in the rivers during monsoon but reduced in the dry period.	Navigational connectivity between the haor and the peripheral river remains operative during monsoon. Besides, navigation also operates through the breached points and public cuts before repairing in February/March. Moreover, boats can ply within the haor for fishing and other purposes.	The navigational connectivity has not been affected in monsoon but it does not operate during pre-monsoon due to repair of submersible embankment. Navigation in the peripheral river has not been affected.
Land Resources			
Land use(ha)	Gross area:1443	Gross area:1445	i)NCA:+48

Indicators	Pre Project	Post Project	Impact
	i)NCA :1,822 ii)Others:408	i)NCA:1,083 ii)Others:360	ii)Others:-48
Land degradation	Sand carpeting: 15ha	Sand carpeted area converted to agricultural land	Sand carpeted area converted to agricultural land
Agriculture Resources			
Cropping intensity (%)	116	118	+2
Cropped area (ha)	Rice: 1,149 Non Rice: 52	Rice: 1,148 Non Rice: 130	Rice:-1 Non Rice: +78
Crop production (ton)	Rice: 2,050 Non Rice: 932	Rice: 3,122 Non Rice:1,812	Rice:+1,072 Non Rice: +880
Crop damage (ton)	Rice: 326 Non Rice: 207	Rice: 611 Non Rice:202	Rice:+285 Non Rice: -5
Irrigated area (ha)	Rice: 0 Non Rice: 52	Rice: 303 Non Rice: 130	Rice:+303 Non Rice: +78
Surface water Irrigation availability	Available	Deficit during month of February to March	Deficit
Agro-chemicals use (ton or kiloliter)	Fertilizers: 0 Pesticides: 0	Fertilizers: 235 liquid pesticides: 0.8 Kelo liter, granular/ powder pesticides: 2 ton	Fertilizers: +235 liquid pesticides: +0.8Kelo liter, granular/ powder pesticides: +2 ton
Livestock Resources			
Livestock population (number)	Cattle:1,450 Goat:390 Chicken:4,910 Duck:1,670	Cattle:2,020 Goat:590 Chicken:5,810 Duck:1,910	Cattle:+570 Goat:+200 Chicken:+900 Duck:+240
Fisheries Resources			
Fish habitat area	• Fish habitat was about 1052ha. • Of which capture 1047 ha, • Culture 5 ha.	• Total fish habitat is 1022 ha. • Of which capture 1012 ha. • Culture 10 ha.	• Overall decrease the fish habitat 30 ha. • Decrease the capture fish habitat area 35 ha. • Increase the culture habitat 5 ha.
Fish habitat condition	• The fish habitat and water quality was comparatively good in pre Intervention period. • Agrochemicals and pesticides and fertilizer use was limited. • Some beel area was untouched from fishing. That helps for next year recruitment of fishes.	• The use of agrochemicals and pesticides and fertilizer has increase due to boro cultivation. So water quality is degrading day by day. • Water also polluted by wastages of homestead, market and other anthropogenic activities.	• Habitat quality and water quality degrading by incremental use of agrochemicals, pesticides and fertilizer in boro field and polluted by wastage from different sources. •
Fish Diversity	• About 80 fish species are available in study.	• Fish species is same but changing of some species abundance.	• Decrease the abundance of some species mainly small indigenous species (SIS) fish species.
Fish migration	• Fish migration	• Disrupted due to	• Impeding of fish

Indicators	Pre Project	Post Project	Impact
	status was smooth. The fishes move easily from one place to another without any barrier.	embankment and regulator and raising the bed of khal and beel.	migration and delayed fish breeding especially the small fishes in some extent.
Fish production	• Overall fish production was 151 MT per year. • Of which from capture production was about 150MT. • From culture production was about 1 MT.	• Total fish production is about 749 MT per year. • Of which from capture production 529 MT. • From culture production about 220 MT.	• Increase of fish production about 598 MT per year.
Fishing Appliances	• Different types of fishing gears namely current jal thela jal, ber jal, puti jal, koi jal, khora, borshi, Gui was used to catch the fishes. The mesh size of net was 2 to 3 cm.	• Fishing gears are almost similar. But at present the fishers are using some new net and traps like kona jal / moshari jal (small mesh size net below 0.5 cm) that damaging the fish fry as well as fish habitat.	• Decrease the fish abundance and destroy the fish habitat productivity.
Fishers Livelihood	• Only the Hindu fishers was involve with fishing. Numbers of Muslim fishers was limited.	• Numbers of Hindu and Muslim fishers has increased partially but part time fishers increased rapidly. • Good numbers of peoples are involved for their livelihood as fish retailer, fish aratder, ice producer, fish labor, transport worker etc.	• Increasing the fishing pressure on study areas and the real fishers are losing the benefit. • Increasing the participation of different types of peoples for their livelihood.
Fisheries Management	• There was no limitation on fishing in pre Intervention. Even some of the perennial water bodies was kept as it is for next year propagation. • The professional fisher never catch fish by de-watering.	• In monsoon the fisher catch fish in study without any restriction. But in post monsoon fishing, not allow in the private own beel and adjacent area.	• Fishing access is limited especially in privately own beel and adjacent area. • Professional fishers are not getting any benefit in post monsoon period. And decreasing the fishing right.
Ecosystem			
Terrestrial flora	Most of the Indicator species were common or occasional	Insignificant change of abundance of Hizol tree due to agricultural expansion	Sluice is indirectly responsible for boosting crop production
Terrestrial fauna	Status was common for most of the indicator species	Status have changed for habitat disturbance and application of insecticides	Intervention is not responsible
Aquatic flora	Indicator species were common	Abundance and population have been reduced due to expansion	Intervention is not responsible

Indicators	Pre Project	Post Project	Impact
		of agricultural practice and overfishing	
Aquatic fauna	Indicator species were common	Changes have been occurred for habitat destruction by siltation and anthropogenic pressures	Intervention is not responsible
Swamp Forest and Reedland	Reedland was existed in some areas	Some portions have converted to cropfield with expansion of agricultural practices	Sluice is indirectly responsible for boosting crop production
Ecosystem goods and services	Optimum	Reduced supporting and regulating services for landuse change and population growth but increased provisioning services	Submergible embankment is positively responsible for boosting up provisioning services
Socio-economic Conditions			
Employment Opportunity	Total cropped area was 1201 ha whereas about 130 man days labour (per hector) inputs were needed.	Total cropped area were 1278 ha where about 137 man days labor input were needed. The technological use reduced labor input	• The demand for labor increased due to the increase in total crop area. • 16,703 mandays labor input increased during the Post Project period.
Agriculture production and wage base income	• The total agricultural production base average income were about • BDT 669.98 lakh • The agricultural wage base average income was about 645.90 lakh.	• The agriculture production base income after the period of after project is about • BDT 1069.18 lakh • The agricultural wage base average income is 712.72 lakh	• About 399.19 lakh agriculture base income increased due to the project intervention in this Haor region • Agricultural wage base labor income increased (66.81 lakh) during the period of after project due to the increase of total cultivable land
Land Price	The price of agricultural land was BDT 30,000 to 70,000 per keyar[8] and BDT 60,000-100,000 for homestead land.	The price of agricultural land is near to be BDT1.0 lakh to 4.BDT0 lakh whereas the price of BDT5.0 to 8.0 lakh for homestead lands	• The opportunities for agricultural production were increased in which the value of agricultural lands was being increased with the period of after project condition. • The price of low land area is declining due to early flash flood and regular damage of agricultural production
Accessibility in Health and Educational institution	The price of agricultural land was BDT 30,000 to 70,000 per keyar[9] and BDT	The price of agricultural land is near to be BDT1.0 lakh to 4.BDT0 lakh whereas the price of	• The opportunities for agricultural production were increased in which the value of agricultural

[8] 1 Keyar = 33 decimals

[9] 1 Keyar = 33 decimals

Indicators	Pre Project	Post Project	Impact
	60,000-100,000 for homestead land.	BDT5.0 to 8.0 lakh for homestead lands	lands was being increased with the period of after project condition. • The price of low land area is declining due to early flash flood and regular damage of agricultural production
Labor and Seasonal Migration	• The Net demand for labor per ha near about 130 and about 50% labor came from outside than the locality.	• The net demand for agricultural labor is near about 137 per ha whereas most of the labor come from the local areas	• The technological innovation in agriculture was increased that somehow lessen the demands of agricultural labor • Due to regular flash flood and damage in agricultural; production the rates of forced migration (10%) is being increased.
Institution and Governance	• Local Union Parishad used to manage local water resources and Beels and Haors were managed by Deputy Commissioner at district level	• The institutions (i.e. BWDB) constructed embankments and has been conducting O&M of infrastructures • Local people's participation in planning and management has been insufficient land hence governance ineffective.	• Institutional presence (of BWDB) is seen but efficiency of flood control system is at the low ebb. • In absence of participatory management body within Haor, the governance position does not turn out meaningful.

10. Environmental Management Plan

10.1. Management Plan

Impact	Mitigation Measures	Enhancement Measures
Flooding	• The submersible embankment should be repaired as per design section within the month of February every year. • Causeway should be constructed at suitable locations to avoid major damage of embankment by public cuts. • Awareness raising program should be carried out against public cut. The bills, khals and rivers should be dredged/ re-excavated to increase carrying capacity and thereby reducing the impact of flood. • The dredging work should be done in a proper way so that the embankment do not get eroded.	
Drainage	• Required number of sluice and pump house should be constructed to facilitate faster drainage. • Proper maintenance of pump house should be ensured. • The conflict of fishers and farmers with regard to complete drainage should be resolved satisfying both sides' needs.	
Sedimentation	• Internal khals and peripheral rivers should be re-excavated	
Navigation	• The Dauki River should be dredged regularly. • The outlets should have boat pass facility to maintain navigational connectivity • Judgment of local stakeholders and fishermen should be considered. • The dredging work should be done in a proper way so that the embankment do not get eroded.	
Decreased cropped area	• Kanda should be utilized for vegetables cultivation. • Hydroponics or floating bed vegetables cultivation should be introduced or strengthened.	-

Impact	Mitigation Measures	Enhancement Measures
	• Medium high and medium low land should be utilized for short duration and submergence tolerant T Aman (BINA dhan7, BINA dhan 11, BINA dhan12 and BINA dhan 13) cultivation. • Flood tolerant submergence variety (BRRI dhan51, BRRI dhan52 and BRRI dhan79may be tested.	
Increased crop production	-	• Crop area should be increased by utilization of fallow land. • Short duration high yielding and hybrid varieties should be developed/introduced/strengthened. • Crop damage should be minimized by timely and proper rehabilitationof water control structures like embankment, regulators, drainage sluices etc.
Decreased irrigated area and Availability of irrigation water	• Regular re-excavation/dredging of the Dhaleswai riverhas to be ensured in order for retention of irrigation water.	• Re-excavation of existing beels and khals should be ensured for retention of irrigation water. • Irrigation water should be ensured by stopping drainout the beels during early dry seasonfor fish harvesting.
Status of livestock/poultry	-	• Grazing area should be increased by utilizingfallow land. • Awareness build up through training • Marketing facilities should be improved. • Availability of high yielding breed should be ensured.
Increased crop damage	• Height of the embankment should be improved as per design level. • Repairing of embankment fromAsam para to Sankibhanga. • Overall of the whole embankment is to raise upto 2-4 ft. height through earthwork from existing level of the embankment for saving boro crops. • Regular maintenance work is needed on compartmental embankment by BWDB. • Embankment should be repaired during November to December. • Repairing of embankment at vulnerable point at Asam para and Sankibhanga Mouza. • Regular dredging of the rivers	

Impact	Mitigation Measures	Enhancement Measures
	has to be ensured in order to reduce the intensity of flash flood. • Rehabilitation works should be finished by February • Quality materials should be used for rehabilitation works. • Short duration high yielding or hybrid varieties should be used instead of long duration BRRI dhan29 variety. • Local varieties should be transplanted in the deeper part of the haorarea instead of short height high yielding or hybrid variety.	
Increased use of agro-chemicals	• Farmers should be encouraged to use organic manure to increase soil fertility while avoiding water contamination and reduce the soil fertility. • Farmers should be encouraged to cultivate leguminous crops to enhance the soil quality. • Farmer should be follow modern agricultural technology like Integrated Pest Management/Integrated Crop Management(IPM/ ICM), Good Agricultural Practices(GAP) etc.	
Decreasing the fish habitat and water quality.	• Fishing by kona jal / moshari jal (small mesh size 0.5 cm net) should be banded round the year. • Optimum use of agrochemicals and pesticides and fertilizer.	• Monitoring should be conducted through fishers' communities by the guidance of related upazila fisheries officer to protect the fishing by kona jal / moshari jal (small mesh size net). • Optimum use of agrochemical should be ensure through monitoring by Department Agriculture Extension (DAE).
Decrease the richness and disappearing of some fishes.	• Use of small mesh size net like moshari jal / kona jal should be banded round the year.	• Monitoring should be conducted through fishers' communities by the guidance of upazila fisheries officer to protect the fishing by moshari jal / kona jal.
Hampering of fish migration	• Gate of regulator should be open in pre-monsoon and monsoon period for smooth migration from khal to beel or beel to khal.	• Proper maintenance of regulator should be conducted and monitored by the local community or Project Implementation Committee (PIC).
Increasing the fishing pressure.	• Only ID card holder permanent and part time fishers (no need of ID card for subsistence fishers) should allow to catch fishes.	• New ID card should be provided to the new fishers through proper judgment by the registered fishers committee in collaboration with related upazila fisheries officer.

Impact	Mitigation Measures	Enhancement Measures
Decreasing of water area.	• Two ha of water area of Hidoli beel should be kept as protected area round the year for next year recruitment.	• The protected area should be guarded especially at night by the professional fishers of management committee of adjacent village. • Management committee should be formed by 7 or 9 members. The committee members are fishers' local elite, teacher, UP member, student and other community members. • The committee activities should be guided by Jointapur upazila fisheries officer. • And use of sign board and red flag in the protected beel.
Terrestrial Flora	• Keep untouched the kandas and village grooves of Govt. kahsh land • Initiate plantation programme along the river levees, kandas and other khash lands	
Terrestrial Fauna	• Identify the core habitat for the threatened animals and take action to conserve the respective habitats • Increase people awareness about wild life conservation • Initiate Govt. for conserve respective amount of natural vegetation and reedland in each haor area	
Aquatic Flora	• Control over harvesting of aquatic resources	
Aquatic Fauna	• Initiate commercial production of freshwater snails for meeting up duck feeds	
Swamp Forests and Reddlands	• Take initiation of swamp tree plantation at larger 'kandas' which are owned by the Government	
Ecosystem goods and services	• Implement proper landuse planning including natural vegetation and wildlife conservation provision	• Aware local people to optimum use of natural resources
Livelihood and employment opportunity • The Regular flash flood and damage of agricultural production made constraint in people's living and livelihood	-	• Embankment must be repair using the local labor • Training would be ensured for the creation of alternative livelihood options • Soft loan would be provided especially in the emergency period (i.e. post flooding condition) due to the damage and water logging at the Haor region.
(Agriculture and wage base income) • Agricultural production and	• A Master plan should be prepared to reduce water logging problem at Dhaleswai	• New variety in production with the changes of seasonality should be initiated

Impact	Mitigation Measures	Enhancement Measures
wage base income was increased due the project intervention. • From people's point of view, Due to long time water logging agricultural production and labor base income is one the way to be declined	Haor region	• Innovative training programs should be initiated to cope up with the changing technology
Land Price • The opportunities for agricultural production were increased in which the value of agricultural lands was being increased with the period of after project condition. • Regular flash flood occurred in last decades made a concern to the local people, as a result the price low land decreasing.	• Proper Maintenance is important with the participation of local stakeholder's concern. • A water management group should be more functional to provide suggestion for water management issue. • A long term planning should be prepared with the help of local stakeholders.	• Regular Maintenance and protection work should be implemented properly to keep the land arable • The siltation during the flash flood would be controlled through the development of regular monitoring system
Accessibility in Health and Educational institution • The communication system became easier after the time of project intervention. • Due to lack of proper maintenance, the damage of the embankments was increased and local people started to face problem to use these embankments as their means of communication.	-	• A monitoring Committee should be formed in association with WDB and local people to identify damaged area. • A hot line (i.e. calling system) should be developed to get regular update, flooding condition and damage information during the emergency • Design of operation and maintenance (i.e. Submergible embankment) would be ensured through the participation of local stakeholders
Institution and Governance • There is no mechanism to consider local people's ideas and concerns while drawing project operation and maintenance systems. Project people suffer crop loss and other household vulnerabilities. • The role of institution to consider public demand in policy, operation and maintenance on the issue of those submergible embankments.	• Quarterly Meeting should be initiated with local water and flood protection committee to understand the gap of institutional policy and governance • A functional Monitoring team should be formed to visit embankments cum road • People's feedback should be taken before the implementation of any kind of policy in relation to new project and maintenance and operation of those submergible embankments.	-

Appendix: A

Photo Album

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Agriculture Resources

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Focused Group Discussion

Halir Haor System

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1 Introduction

1.1 General Information

The Halir Haor lies in between in between 25°01'34.16" and 25°01'38.71" latitude and between 91°06'05.35" and 91°09'33.02" longitude in the district of Sunamgonj. The project has a gross area of about 8774 ha. The project mostly lies within Jamalgonj upazila while the northern portion lies under Taherpur upazila and north-eastern part is under Bishwambarpur upazila. It encompasses covering Bahali, Jamalgonj sadar and Sachna bazaar unions of Jamalgonj upazilla; Sripur union of Taherpur upazila and Fathapur union of Bishambarpur upazila. The shape of the haor is semi triangular. This haor is lower compared to other surrounding haors and rivers. The southern part of this haor is relatively high and the deepest part is in the north-western and central parts. The land surface of the haor is very undulating ranging from 6.04m+PWD in the north-eastern side and 0.24m+PWD in the south-western side. The average land elevation of the haor is about 3.31m+PWD.

The main river connected with Halir Haor is Surma River which flows along its western and northern peripheries. Besides Surma, Baulai River flows along the north-east side and Piyani river and Abua river flow along the southern side. Moreover, there are a number of small water bodies and canals inside the Halir Haor project. Mentionable are Chatti Dhara beel, Koer beel, Hekkar beel, Goinnar beel, Jignar beel, Boala beel, Kosma beel, Nindi beel, Goarai beel which are used as a source of fish habitat and irrigation. A number of these beels are connected with important khals namely Noyakhara khal, Kalagonj khal, Kailani khal, Langutikhara khal, Putai khal, Ratla khal and Sanggang khal. These khals mainly serve as an artery of the local drainage system and drain out water in the post monsoon season. On the other hand farmers take water into the haor area in the dry season for irrigation. There are several haors adjacent to this project, namely Shonir haor, Sonamoral haor, Pangar haor, Mohalia haor, Matian haor and Angurali haor.

Project Descriptions

Bangladesh Water Development Board implemented the Halir Haor project and in 1988 with GOB funds. The major physical interventions of the project are submersible embankment and closures of several beels. The main objective of the project was to protect crops and provide safety to the local people from flash flood.

The water management infrastructures of the Halir Haor scheme include the following:

- 72 km embankment (including around 12 km compartmental embankment),
- 2 number of regulators and
- Around 5 kms drainage canal;

Present status of the project interventions

Major interventions include submergible embankment and some different types of appurtenant hydraulic structures like regulators, inlet, outlet and pipe sluice. Submersible Embankments are the most common structural interventions in this region. It is observed that along majority part of the embankments, the crest level recedes from the design crest level, existing cross-sections receive damage compared to design cross-section and breaches of embankments are found at numerous locations Breaches allow water entrance into the haor areas before harvesting of boro crops is done leading to severe damage to the crops. Moreover, Public cuts have been observed at different locations along the embankments due to lack of boat pass. Submersible embankment with Lowered crest level is incapable of serving its purpose. In this haor, two regulators have been observed. One of those are functioning well, however the other one is in non-functional state. Reasons behind low or non-functionality of hydraulic structures include: poorly fitted gates resulting to seepage flow, stresses relating to mechanical operation and missing of some valuable components of gates and hoist system, silted up linked canal creating drainage congestion etc.

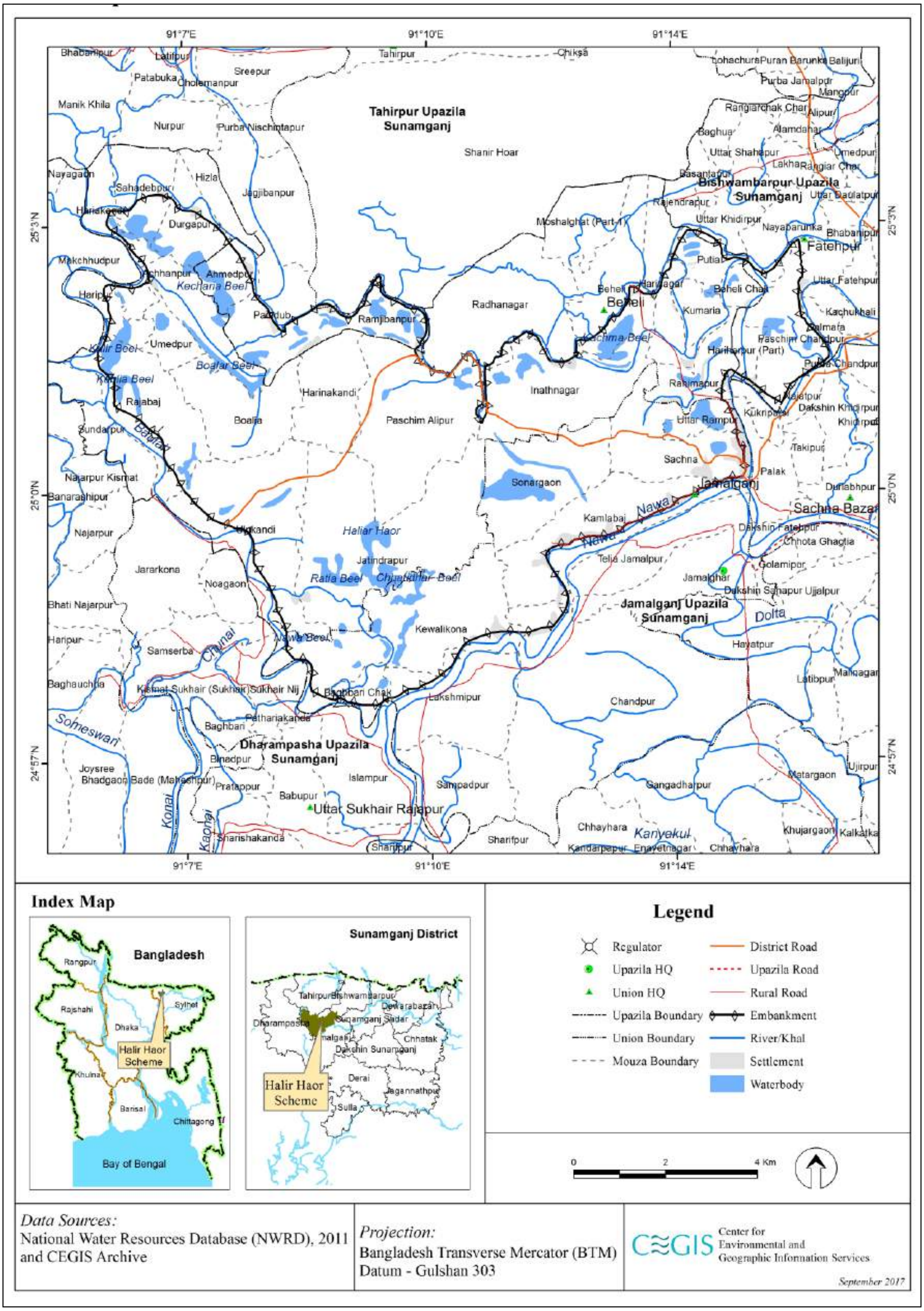

Figure 1.1: Hydrologic Features of Halir Haor system

2 Water Resources

2.1 Flooding

Pre Project

Before construction of any type of intervention, flash flood due to heavy rainfall in the upstream region during pre-monsoon period flowed through the Surma River and frequently damaged the standing crops. Usually the flash flood entered in mid-April and at times in mid-March before construction of submergible embankment and water stayed up to seven months in the haor region. The early flash flood caused severe damages to crops and livelihood of the haor and every year people lost almost 75% of the crops. To tackle the problems, local people made temporary earthen dam across the khals so that they could harvest their standing crops.

Post Project

After implementation of the submersible embankment and closures by BWDB in 1988, entrance of flood into haor got delayed by 8 to 12 days. After that, the flash flood enters in the haor through channels internally and overtops the submersible embankment in last week of April and inundates the entire haor within 8 to 10 days. According to information of local people, after the project, crop damage has been reduced to 30%. However, the flash flood sometimes comes early due to excessive rainfall in the upper catchment like it happened in 2004 and 2017. The devastating flash flood in 2004 inundated the entire haor area in the first week of March and damaged almost entire crops. It caused immense sufferings to the locality. Some segments of the embankment and closures were breached. At present, the crest level of the entire embankment was found to be lower than the design level. As a result, flash flood enters the haor area within seven days which is supposed to enter after 8 to 12 days, which causes crop damage and suffering of local people.

Impact

Interventions have reduced the possibilities of earlier entrance of flash flood. However, in recent years (2016 & 2017), flash flood entered into the haor a bit early due to unprecedented rainfall in the upper catchment. On average, around 45% of the haor becomes vulnerable to flood during pre-monsoon which is comparatively lower than the pre project condition.

2.2 Drainage

Pre Project

There are a number of drainage khals inside the Halir haor which helped drain out the flood water as the entire haor area was open. According to the local people, in pre-project period most of the flood water could be smoothly drained out to the connected rivers through the drainage khals and only some water got retained in the low-lying beels. People made several earthen dams on the internal khals to conserve water for irrigation during dry season. They did not face drainage congestion and water logging problem at large scale before implementation of the interventions.

Post Project

The drainage system of the haor has been changed after implementation of the project. The closures on the khals also caused delay of drainage of the haor. Most of the water is drained out through Baulai River and different khals and canals as the land slope is from northeast towards the southwest. In the dry period, water remains only in the beel areas which covers approximately 4-5% of the entire haor. Besides, fisherman retain water in the beel areas for long time for fish cultivation which delays irrigation.

Impact

According to the local people, Water Development Board operates 2 sluice gates properly which helps drainage of the haor. However, the drainage of the haor got delayed by 7-10 days than the pre-project period. The drainage congested area has been increased compared to pre-project condition.

2.3 Sedimentation and Siltation

Pre Project

Sedimentation did not appreciably effect this haor in pre-project condition. The Baulai River carried very small quantity of sediment since it originates from low-lying beel area. Hence, sedimentation of this haor was not that much problem before implementation of the interventions.

Post Project

The local people informed that Sedimentation in this haor is not a serious problem. Approximately 1-1.5 inch siltation has so far taken place in Gopalpur, Barukori, Kutiya, Bagani, Behli, Alipur and Hasalpur.

Impact

Sedimentation is a natural process in this area. Moreover, it is beneficial as the land fertility increases due to siltation.

2.4 Navigation

Pre Project

The navigation system in this area was mainly observed in Baulai and Surma River. In the dry season, no internal navigation system was observed within the haor area. During monsoon, navigation is the major mode of travel of the local people and carrying goods.

Post Project

There is no significant change in the navigation before and after the intervention. After implementation of submersible embankment, only internal fishing boats cannot go to the peripheral rivers. However, communication system has improved tremendously in dry season, due to construction of submergible embankments. Mentionable places are Syadpur, Alipur Haripur, Harinakandi, Ahsanpur, Jotindrapur and Humaitpur.

Table 2.1: Types of Water Vessels

Types of Vehicle	Number of Vehicle	Person per Vehicle	Oil Consumption (per day)	Oil Leakage (per day)
Small Boat (Non-Motorized)	Approximately 1600	3-5 person	No Consumption	No Leakage
Medium Boat (Motorized)	600-800	8-10 person	4-5 Litre Diesel	0.5 Litre
Large Boat (Motorized)	More than 200	18-22 person	12-14 Litre Diesel	1-1.5 Litre

Impact

There is no significant changes in navigation after implementation of the interventions rather number of vessel if increased.

3 Land Resources

The project area has fallen in one Agro-ecological zone, namely: Sylhet Basin (AEZ-21). Acid basin clays is the dominant soil. The top soil texture are clay and clay loam; where clay texture is dominant. The soils are slow permeable and have a medium moisture holding capacity. The land type characteristics are not uniform within the project area. About 79% of cultivable areas are low to very low land where minimum flooding depth is above 1.8 meter during the monsoon period. The recession of surface water from most of the agriculture land starts at middle of December and become free of flood water in late January.

Two indicators (Land use and Sand carpeting area) have been selected for assessing the impact on land resources due to structural interventions in Haor ecosystem. The land use and sand carpeting information under pre-project and existing situations were identified through analysis of the available archived satellite images of CEGIS and it was verified through Focus Group Discussion (FGD) and Key Informant Interview (KII).

Though the project has been completed during 1988, assessment of land use change has been performed on the basis of available LandSAT image of 1989 and 2015 keeping in consideration that land use of 1989 represents the equivalent land use of earlier of project implementation.

3.1 Land Use

Pre Project

The gross area was 8,774 ha of which the Net Cultivable Area (NCA) was 5,759 ha in this haor. The rest area was covered by rural settlement with vegetation, others and water bodies. Details are presented in Table 3.1.

Post Project

The gross area has been considered as same under with project situation and the Net Cultivable Area (NCA) is 6,741 ha. The rest area was covered by rural settlement with vegetation, others and water bodies. Details are presented in Table 3.1.

Impact

The Net Cultivable Area and rural settlement area is increased but water bodies and others area is decreased. Detailed impact of land use is presented in Table 3.1:

Table 3.1: Detailed Land Use in Halir Haor

Land use	Pre-project	Post-project	Impact
Net Cultivable Area (NCA)	5,759	6,741	982
Others	2,702	1,697	-1005
Rural Settlement with Vegetation	93	155	62
Water	220	181	-39
Total	**8,774**	**8,774**	**0**

Sources: CEGIS estimation based on field information, September 2017

3.2 Land Degradation

No sand carpeting was found before or after implementation of the project.

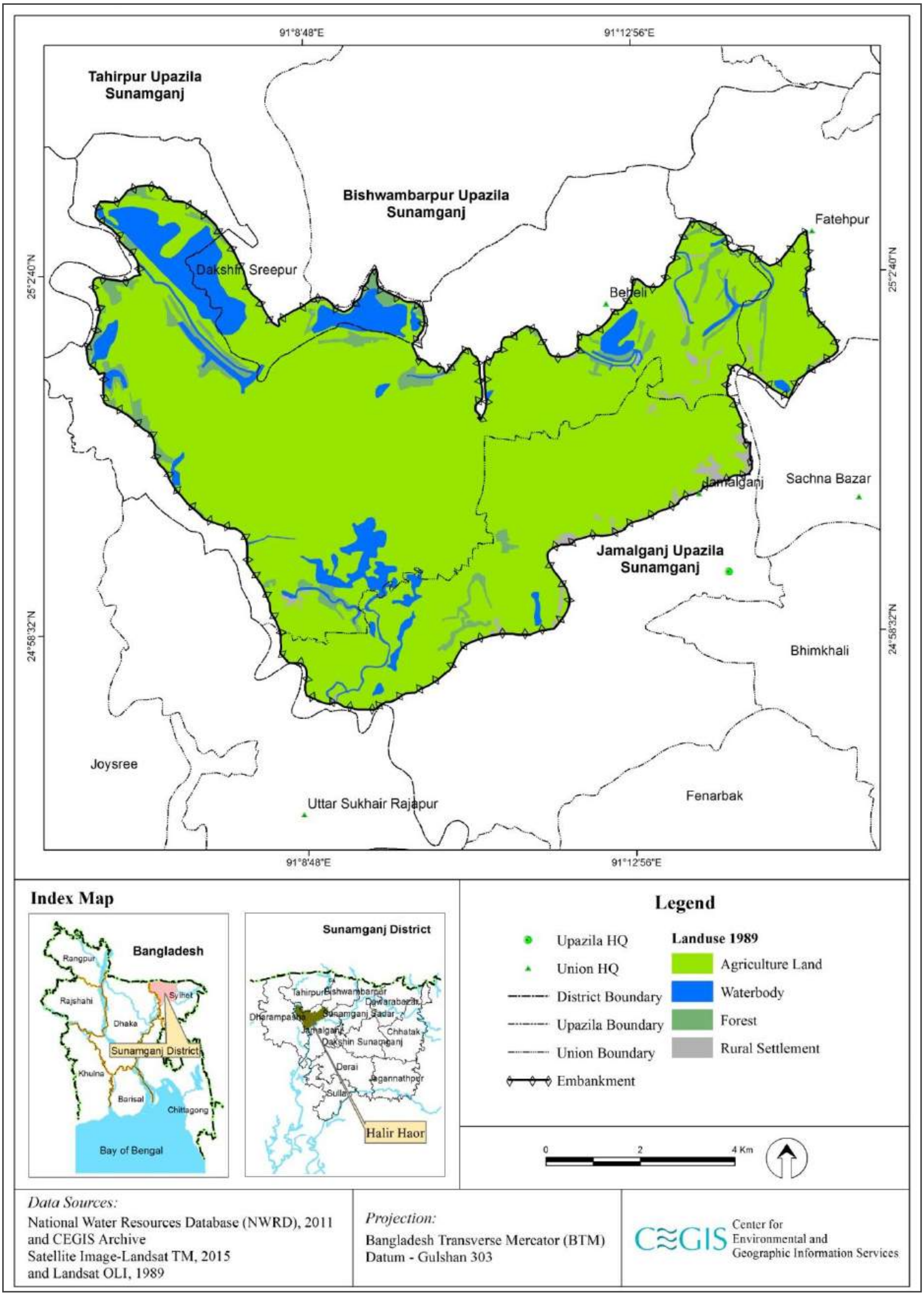

Figure 3.1: Land use of Halir Haor System (1989)

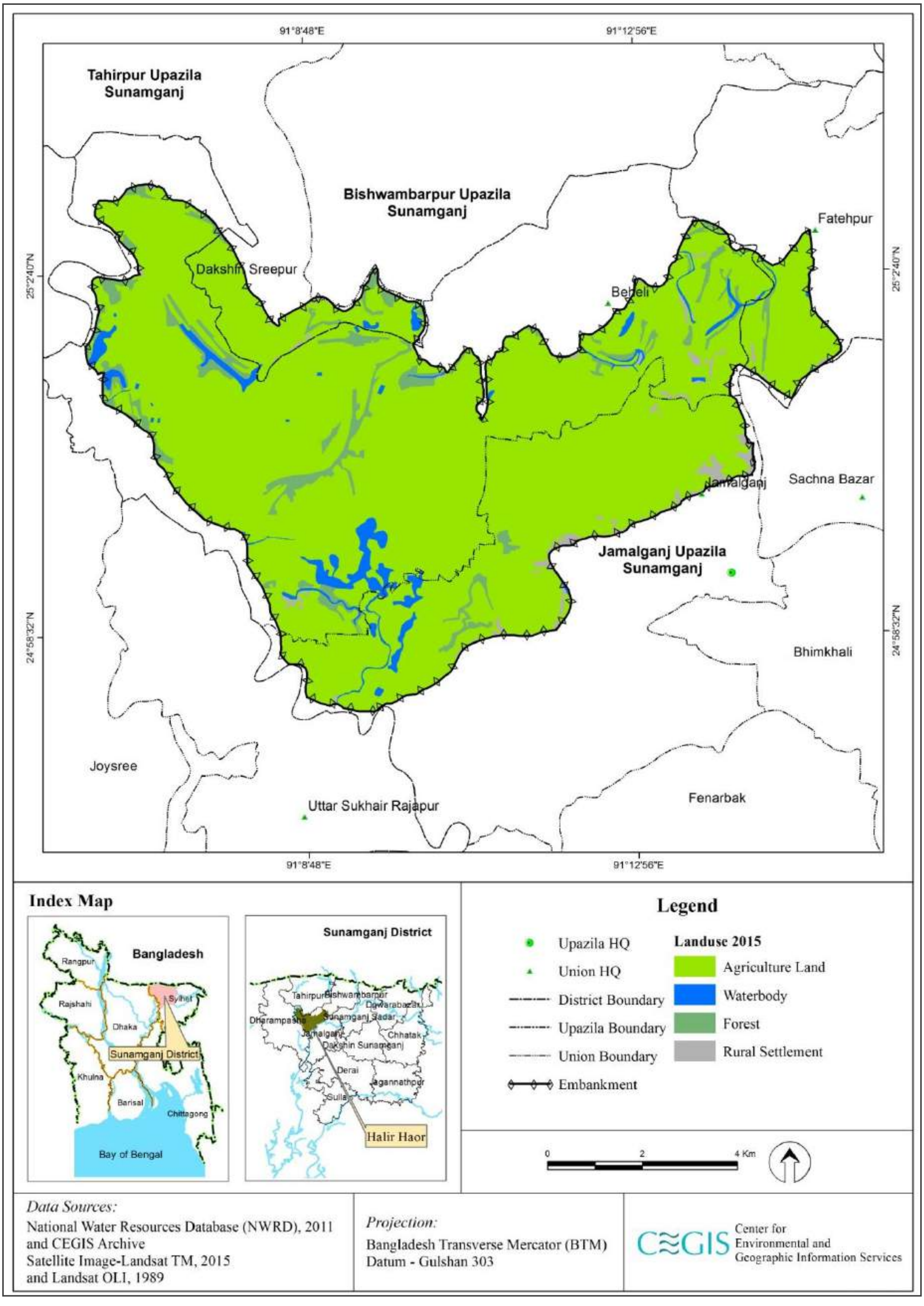

Figure 3.2: Land Use of Halir Haor System (2015)

4 Agriculture Resources

Boro rice is the main crop in Haor areas. In most cases, pre-matured or matured Boro crops are damaged by early flash flood which generally happened due to pre-monsoon heavy rainfall in the hilly areas. Besides, drainage congestion and irrigation water scarcity due to siltation of rivers, khals and beels are the another problem for Haor agriculture.

Six indicators (cropping intensity, crop area, crop production, crop damage, irrigation and use of agro-chemicals) have been selected for assessing the impact on agriculture resources due to structural interventions in Haor ecosystem. The information of these indicators were collected from both primary and secondary sources. The primary data were gathered from stakeholders through Focus Group Discussion (FGD) and Key Informant Interview (KII). The secondary data were collected from Bangladesh Bureau of Statistics (BBS) and field level Department of Agricultural Extension (DAE) office.

4.1 Cropped Area, Cropping Pattern and Intensity

Pre Project

Before implementation of the project interventions, the Net Cropped Area (NCA) was 5,759 hectare, where dominant cropping pattern was Fallow-Fallow-Local Boro. The land type of this project area was very low land (about 66% of NCA) followed by medium low land, low land and medium high land as presented in Table 4.1.

Farmers usually grew local Boro and HYV Boro crops in Rabi season. Different varieties of local Boro like Gochi, Boro, Tepi Boro and Shail, and HYV Boro like BR19, BRRI dhan28 and BRRI dhan29 were very much popular among the farmers. As total project area was single cropped, cropping intensity of this area was 100%. Detailed cropping pattern by land type under pre project situation is presented below in Table 4.1.

Table 4.1: Pre-project Cropping Pattern of Halir Haor

Land type	Pre project				
	Kharif-I (March-June)	Kharif-II (July-October)	Rabi (November-February)	Area (ha)	% of NCA
Medium high Land(F_1)	Fallow	Fallow	HYV Boro	288	5
Medium Low Land(F_2)	Fallow	Fallow	HYV Boro	921	16
Low Land(F_3)	Fallow	Fallow	HYV Boro	749	13
Very Low Land(F_4)	Fallow	Fallow	Local Boro	3,801	66
			Total	**5,759**	**100**
			Cropping intensity (%)	**100**	

Sources: CEGIS estimation based on field information, September; 2017

Post Project

The project area became protected from early flash flood due to the interventions, which influenced farmers to grow Hibrid and HYV Boro crops instead of local and HYV Boro. Hybrid and HYV Boro crops also produces higher yield than local varieties. The most popular varieties which are used in the project area are BRRI dhan 28 and BRRI dhan 29. The Net Cultivable Area (NCA) has been increased to 6,741 hectare after interventions. Dominant cropping pattern of the project area is Fallow - Fallow - HYV Boro covering 87% of the NCA. The total project area is covered with single cropped area. So, the cropping intensity remained same, which is 100%. Detailed cropping pattern by land type under with project situation is presented in Table 4.2.

Table 4.2: Post-project Cropping Pattern of the Halir Haor

Land type	After Interventions				
	Kharif-I (March-June)	Kharif-II (July-October)	Rabi (November-February)	Area (ha)	% of NCA
Medium high Land(F_1)	Fallow	Fallow	HYV Boro	337	5
Medium Low Land(F_2)	Fallow	Fallow	HYV Boro	1,079	16
Low land(F_3)	Fallow	Fallow	Hybrid Boro	876	13
Very Low Land(F_4)	Fallow	Fallow	HYV Boro	4,449	66
			Total	**6,741**	**100**
			Cropping intensity (%)	**100**	

Sources: CEGIS estimation based on field information, September; 2017

Impact

The Net Cultivable Area (NCA) has been increased to 982 hectare after taking interventions. The cultivated area of Local and HYV Boro has gradually been decreased and replaced by Hybrid and HYV Boro variety after completion of project due to its higher yield rate and ensured early flash flood protection by project interventions. Impact on cropped area is presented in Table 4.3.

Table 4.3: Impact on Cropped Area in Halir Haor

Crop name	Pre project Area(ha)	Post-project Area(ha)	Impact (Post-project -Pre project)
Hybrid Boro	-	876	876
HYV Boro	1,209	5,865	4,655
Local Boro	4,550	-	-4,550
Total	**5,759**	**6,741**	**982**

Source: CEGIS estimation based on field information, September; 2017

4.2 Crop Production

Pre Project

The estimated total annual crop production of the project area was about 18,935 tons after loss of 3,647 tons before any interventions. Detailed crop production statistics before interventions is presented in Table 4.4.

Table 4.4: Annual Crop Production in Halir Haor under Pre-project Situation

Crop name	Total crop area(ha)	Damage free area (ha)	Damage free yield (ton/ha)	Damaged area (ha)	Damaged yield (ton/ha)	Annual production (ton)	Production lost (ton)
Local Boro	4,550	3,185	3.9	1,365	1.6	14,606	3,140
HYV Boro	1,209	1,028	4.0	181	1.2	4,329	507
Total	**5,759**	**4,213**	**-**	**1,546**		18,935	3,647

Source: CEGIS estimation based on field information, September; 2017

Post Project

After the implementation of the project, hydrological regime of the project area is changed. Farmers started to cultivate Hybrid and HYV Boro due to presence of submersible embankment, compartmental embankment, regulator and closure, which protect their crops from early flash flood. Hence, total annual crop production is about 29,643 tons with loss of 8,746 tons after interventions. Detailed estimation of crop production after interventions is presented in Table 4.5.

Table 4.5: Annual Crop Production in Halir Haor under Post-Project Situation

Crop name	Total crop area(ha)	Damage free area (ha)	Damage free yield (ton/ha)	Damaged area (ha)	Damaged yield (ton/ha)	Annual production (ton)	Production lost (ton)
HYV Boro	5,865	3,519	5.5	2,346	2.1	24,281	7,976
Hybrid Boro	876	701	7.0	175	2.6	5,362	770
Total	**6,741**	**4,220**	-	**2,521**	-	29,643	8,746

Source: CEGIS estimation based on field information, September 2017

Impact

Additional 10,708 tons rice is being produced in post project situation. The rice production is increased due to the protection of flash flood which encourages the farmers for practicing high yielding variety instead of local variety. Detailed estimation of impact on crop production is presented in Table 4.6.

Table 4.6: Impact on Crop Production in Halir Haor

Crop name	Pre-project production(tons)	Post-project production(tons)	Impact (Post-project-Pre-project)
Hybrid Boro	-	5,362	5,362
HYV Boro	4,329	24,281	19,952
Local Boro	14,606	-	-14,606
Total	**18,935**	29,643	**10,708**

Source: CEGIS estimation based on field information, September 2017

4.3 Crop Damage

Pre Project

Flash flood was the main cause of crop damage in pre-project situation. Before harvesting of Boro crop, water entered into the haor area and damaged the crops. So, farmer of this area suffered due to damaging of their crops in every year. Total crop damage in the project area was 3,646 tons annually. Detailed estimation of crop damage is presented in Table 4.7.

Post Project

Halir haor is now protected from early flash flood by the project interventions which basically performed well up to 2013. After that, most of the year, flood water enters into the project area before harvesting of Boro crop (early to mid-March) due to low height of submersible embankment and malfunctioning of structures.

Floodwater enters into the project area through the surrounding river either by overtopping or by breaching the embankment at several locations. The height of embankment of the haor is low in comparison with the design level and more than 10 breaches are located in this embankment. Every year BWDB closes the major breaches and entrances of the khal. The main reason for flooding in this haor over the years is that the rivers have silted up and their water flowing capacities are gradually reducing. The excessive sedimentation makes rivers incapable of holding and conveying floodwater, which creates excessive pressure on earthen embankment. Moreover, plant height of HYV is less than local varieties and growing period of most of the HYV varieties are higher than local varieties except BRRI dhan 28. So, flood water affects the whole crop area at a time. The devastating floods of 2004 inundated the project area on the mid-week of April. Local people reported, around 80% of Boro both HYV and Hybrid varieties were damaged by the devastated flood. In 2007, around 90% of Boro both HYV and hybrid varieties were damaged by the devastated flood. But, this year (2017), around 100% of Boro crop areas are damaged at pre-mature stage. Total crop damage in the project area is about 8,746 tons annually. Detailed estimation of crop damage after interventions is presented in Table 4.7.

Impact

Though, the crop damage area has been decreased from 20% to 40% after interventions. However, crop damage has been increased 5,100 tons because the total production has increased significantly. The crop damage area is increasing day by day due to malfunctioning of the interventions and reduced water carrying as well as retention capacity of surrounding rivers, khals and beels. Detailed impact assessment on crop damage is presented in Table 4.7.

Table 4.7: Impact on Crop Damage in Halir Haor

Crop name	Pre-project production loss (tons)	Post-project production loss (tons)	Impact (Post-project - Pre-project)
Hybrid Boro	-	770	770
HYV Boro	507	7,976	7469
Local Boro	3,140	-	-3,140
Total	3,646	8,746	5100

Source: CEGIS estimation based on field information, September; 2017

4.4 Irrigation

Pre Project

Before initiation of the project, only surface water was used for irrigating Local Boro crops. The local people normally transplanted this crop immediately after the floodwater recedes and the land is under shallow inundation. Local farmer reported that they stored water with help of bundh/dyke management and irrigated their crop with the help of flooded water in the low lying part of the Haor. They also used traditional modes like *Seuti, Don and Cone* for irrigating their crop from surrounding rivers, Beels and Khals during dry season. Prior to the implementation of the project, irrigation water was more available than the requirement of crops.

Post Project

After implementation of the project, the irrigation water demand has been increased due to cultivation of high water demanding HYV and Hybrid Boro instead of Local Boro crop. On the other hand, the availability of surface water is being reduced due to siltation of surrounding rivers, khals and beels of the project area. Besides, the Beels is being dried up by bailing out of water in the month of December-January for harvesting of fish. Therefore, the scarcity of irrigation water has been observed from early February to end of March in most of the year. In this time, researve flood water is the main source of surface water irrigation. Mainly Low Lift Pumps (LLPs) is being used for lifting surface water instead of traditional mode.

Impact

There was deficit of irrigation water due to increase of water demand and decrease of water availability during dry season. The irrigation water demand has increased for cultivating high yielding crop variety. On the other hand, surface water irrigation availability has decreased due to siltation of rivers, khals and beels of the project area.

4.5 Agro-chemical Use

Pre Project

Farmers of the project area cultivated HYV and Local Boro in pre-project situation. They didn't apply agro-chemicals for local Boro cultivation. But incase of HYV Boro small amount of inorganic chemicals were used. However, some farmers used inorganic fertilizer like mixed grass and rice straw in the crop field for the restoration of soil fertility.

Post Project

Generally more agro-chemicals are required for cultivating Hybrid and HYV Boro crops. So, farmers applied more agro-chemicals for Hybrid and HYV Boro crop cultivation. Total about 1,694 tons chemical fertilizers and 1.39 Kiloliter liquid pesticides were used in the study area for crop cultivation per year. Detailed use of agro-chemicals under post-project situation is presented in Table 4.8.

Table 4.8: Use of Agro-chemicals in Halir Haor under Post-project Situation

Crop Name	Fertilizer (Kg/ha)			Total (Kg/ ha)	Pesticides		Total	
	Urea	TSP	MP		Liq. (ml/ha)	Gran. (Kg/ha)	Liquid (Liter/ha)	Granular/ Powder (Kg/ha)
HYV Boro	150	60	40	250	200	-	0.20	-
Hybrid Boro	160	60	40	260	250	-	0.25	-

Source: CEGIS estimation based on field information, September 2017

Impact

Use of agro-chemical has increased largely under post project situation compared to pre project situation. Additional 1,361 ton of chemical fertilizers and 1.39 liter liquid pesticides are used for HYV/hybrid crop cultivation in this area. Detailed impact on use of agro-chemical is presented in Table 4.9.

Table 4.9: Impact on Agro-chemicals in Halir Haor

Crop name	Pre-project			Post-project			Impact		
	Total Fertilizer (ton)	Pesticides		Total Fertilizer (ton)	Pesticides		Total fertilizer (ton)	Pesticides	
		Liquid (litre)	Powder /Granular (ton)		Liquid (Litre)	Powder /Granular (ton)		Liquid (litre)	Powder/ Granular (ton)
Hybrid Boro	-	-	-	228	0.22	-	228	0.22	-
HYV Boro	333	-	-	1,466	1.17		1,133	1.17	-
Local Boro	-	-	-	-	-	-	-	-	-
Total	333	**-**	**-**	**1,694**	**1.39**		**1,361**	**1.392**	**-**

Source: CEGIS estimation based on field information, September 2017

5 Livestock Resources

5.1 Status of Livestock Population, Feed and Diseases

Livestock and poultry, being an essential element of integrated farming system, play an important role in the economy of the Haor area. Livestock provides significant draft power for cultivation, threshing and crushing of oil seeds; cow dung as a source of manure and fuel; a ready source of funds; and meat, milk and eggs for human consumption. A large number of livestock are reared in Haor areas but constrained by flash flood causing inundation of large areas during most of the time in the year. This area is famous for duck rearing due to availability of natural feed for ducks in natural large water bodies. All of livestock species suffer much due to shortage of feed, outbreak of waterborne diseases and inadequate shelter facilities. The livestock rearer in the Haor areas do not get fair price due to poor communication as well as lack of marketing facilities.

The indicator status of livestock has been selected for assessing the impact of the project. The status of livestock population data were collected from Livestock Census (1986), Agriculture census (1996 and 2008) of BBS. The status of livestock feed and fodder, diseases, marketing facilities information were gathered from stakeholders through Focus Group Discussion (FGD) and Key Informant Interview (KII).

Pre Project

According to livestock census 1996, the livestock and poultry population in the project area were 18,510 cattle, 1,560 goats, 34,310 chicken and 32,300 ducks (Table 5.1). Before implementation of the project, the major feed available to ruminants was mostly crop residues (rice straw) supplemented with weeds from cultivated fields. They are to depend on naturally grown grasses in Kandas and alongside roads and embankments. Most of the year before implementation of the project, the crops were to damage by early flash flood. As a result, shortage of feed from crop residues, reduction of grazing facilities seriously affect livestock rearing. That time, the small holders were to depend on water hyacinth and other aquatic plant for their cattle. The major poultry feeds were rice bran, broken rice, kitchen wastes like rice, rice-gruel, vegetables, fish wastes etc. In addition, the duck usually scavenge in the nearby waterbodies like haor, beel, khal, river or any other low lying areas; mainly eat various types of aquatic insects, small fish, shell or snails. Major livestock and poultry diseases were Gola Fula (Haemorragic Septicemia), Foot and Mouth Diseases (FMD), Pox and Cholera, Duck Cholera, Fowl Pox and Fowl Cholera etc. The most vulnerable period was between July to November for spreading diseases to livestock and poultry populations. Mortality rate of the livestock/poultry was higher due to poor shelter condition and they lived in unhygienic condition. Marketing facilities was not in good condition and price was also low due to less demand of their products and by products. Producer consumed their products at family level and additional products were sold at local village market.

Table 5.1: Status of Livestock/Poultry in Kalikota Haor

Livestock/ Poultry Category	Pre-project		Post-project		Impact
	No of Households having Livestock	Total No of Livestock	No of Households having Livestock	Total No of Livestock	Number of Livestock Population
Cattle	4690	18510	6690	23790	5280
Goat	670	1560	450	1110	-450
Chicken	5930	34310	7050	42440	8130
Duck	4980	32300	3850	24640	-7660

Source: CEGIS estimation based on livestock census (1996), agriculture census (2008) and field information (October 2017)

Figure 5.1: View of Cattle at Janpur Mouza

Figure 5.2: View of Duck Farm at Sutar Gaon Mouza

Post Project

According to agriculture census 2008, the livestock and poultry population in the project area are 23,790 cattle, 1,110 goats, 42,440 chicken and 24,640 ducks (Table 5.1). After implementation of the project, crop is protected from early flash flood. As a result, the feed availability of livestock is increased due to increase of crop production. However, some of the year, the crops were damaged by early flash flood. In that year, the small holders were depend on water hyacinth and other aquatic plant for their cattle. The poultry feeds are same as in pre project situation. On the other hand, more or less similar diseases are found in post project situation. The mortality rate of the livestock/poultry became negligible during the project period, due to extension works at farmers' level such as immunization and insemination program by Department of Livestock (DLS). Marketing facilities during dry season also improved due to improvement of the communication system by constructing the submersible embankments. Therefore, market prices are increased due to high demand of products and by products.

Impact

From 1996 to 2008, about 5,280 cattle and 8,130 chickens have increased due to the reduction of flood vulnerability, improvement of marketing facilities and strengthening of livestock extension services. On the other hand, the goat and duck population has been decreased to 450 and 7,660 respectively. Details about impact on livestock are presented in Table 5.1.

6 Fisheries Resources

Halir Haor system is bounded by four-river system (mentioned in Water Resource Section) which act as the major water sources for maintaining sustainability of fish habitat. The haor is fed by a number of connecting Khals of which important ones are Ratla Khal, Putia Khal, Noyakhara Khal, Kalagang and Kailani Khal, Sangang (Kalaganj) and Langtikhara Khal. The Haor possesses a large number of Beels of which major ones (sizes vary from 4 to 25 ha) are Chattidhara Beel, Kachma Beel, Ratia Beel, Halir Beel, Kecharia Beel and Lumba Beel. Beel. According to local people, Chattidhara Beel, Ratia Beel, Halir Beel are the main fish breeding grounds of this Haor system. The field investigation revealed that the water centric interventions significantly control the hydrodynamic condition for fisheries resources of this Haor System.

6.1 Habitat Area

Pre Project

Fish habitat has been assessed from the landuse data that is extracted from the satellite image of 1989. The estimated total area of fish habitat of the Haor was about 8,239 ha where capture fishery was the sole contributor. There were some pits/ponds having no dike inundated naturally. These ponds are considered under floodplain habitat. Floodplain shares the major part (about 90%) in the total habitat area followed by Beel, Khal and Baor. The breakdown of functionally different fish habitats of this Haor is given in Table 6.1.

Post Project

Similarly, the estimated fish habitat area has been assessed from the land use data, which extracted from image of 2015, is about 8,191 ha. The increment of fish habitat area by about 505 ha, which is contributed by the expansion of floodplain area of about 385 ha, newly created borrow pit area of about 65 ha , Baor area of 46 ha and fish pond area of 2 ha. On the other hand, the decrement of fish habitat area by about 566 ha, which is contributed by the loss of Beel area of about 519 ha and Khal area of about 47 ha. The habitat area loss offsets the habitat area gain and thus the resultant net gain of habitat area is about 61 ha. The increment of floodplain occurs may be due to siltation of river bed and associated decrease of river conveyance, Beel bed aggravation by loose top soil from agriculture field with run-off water and embankment breached soil, etc. The borrow pit is created for the construction of submergible embankment and cross-road. The breakdown of functionally different fish habitats of this Haor and habitat changes is given in Table 6.1.

Table 6.1: Breakdown of Fish Habitat Area by Habitat Type

Sl. No.	Habitat Category	Habitat Type	Area (Ha)		Impact (Ha) (Habitat Area Change)
			Pre-project, 1989	Post-projet, 2015	
1	Capture Fishery	Channel/Khal	115	68	-47
2		Beel	667	148	-519
3		Floodplain	7457	7842	+385
4		Borrow Pit	-	65	+65
		Sub-Total =	***8,393***	***8,425***	***8239***
5	Culture Fishery	Fish Pond	-	9	+9
		Sub-Total =	13	59	+46
		Grand Total=	**8,393**	**8,427**	***13***

Source: Fish habitat assessment based on field findings and image based landuse data,1989 & 2015.

Impact

The net loss of fish habitat area in the post project condition is about 61 ha, which is negligible (about 0.7%) in compared to pre-project condition.

6.2 Habitat Condition

Pre Project

Floodplain was unregulated; timely entry of water into the Haor; silt carried by the rivers was dispersed over the Haor uniformly; river conveyance capacity was more. Local people opined that the Beels retained water in the dry season at a depth suitable for fishery. Among the Beels, Chattidhara Beel, Ratia Beel and Halir Beel had average depths ranges from about 2.5-3.0 m during dry season. Some of the Beels, such as Goniar Beel, Binner Beel, Hakkiaer Beel, Kosma Beel, Kaprar Beel Chourar were shallow and dried up by bailing out of water in the month of December-January for harvesting fish. There were some Beels with leasing system and the lessee control the Khal mouth to hold water for fish production during recession period and to inhibit water entry into the Haor to protect Boro paddy during the onset of monsoon.

Little better ecosystem was maintained with the exchange of pre-monsoon nutrients between river and Haor; new water breeding stimulation to the small indigenous species (SIS) of fish; higher breeding success; less natural and fishing mortality; rich biodiversity; more sustainable fish production, etc.

Post Project

Floodplain is regulated; floodwater enters into the Haor in the late pre-monsoon; silt deposited on the river bed as dispersion of silt is hindered or restricted by the submergible embankment; decreased river conveyance capacity. Local people opined that some of the Beels retained water in the dry season at a depth less suitable for fishery. Among the Beels, Chhatidher Beel, Ratia Beel and Halir Beel has average depths ranges from about 1.5-2.0 m during dry season. This is happened may be due to wash out of loose soil of agriculture land and breached embankment along with river borne sediment. Some of the Beels, such as Goniar Beel, Binner Beel, Hakkiaer Beel, Kosma Beel, Kaprar Beel Chourar are shallow and dry up by bailing out of water in the month of December-January for harvesting fish.

There are some Beels with leasing system and the lessee control the Khal mouth (in some cases earthen closure made by BWDB, where water regulatory structures are not functioning) to hold water for fish production during recession period and to inhibit water entry into the Haor to protect Boro paddy during the onset of monsoon.

Ecosystem is being degraded gradually but lightly as some of the water control structures are not functioning properly. Exchange of pre-monsoon nutrients between river and Haor is being hindered or restricted to some extent by the submergible embankment; delayed new water entrance into the Haor and hampering breeding stimulation to the small indigenous species (SIS) of fish; in some cases egg deposited in the fish body; lower breeding success; little higher natural and fishing mortality; slightly declining trend in fish biodiversity; less sustainable fish production, etc.

Impact

The net physical condition of habitat is negligibly degraded and corresponding provisioning services of the ecosystem including fish. However, the changes in habitat suitability condition of rivers, Khals and Beels in terms of quality occurred more due to unconventional Beel fishery, illegal fishing (use of chemical fertilizer), extensive use of agrochemicals and pesticides in paddy field, etc. rather than water centric interventions.

6.3 Fish Diversity

Pre Project

This Haor was rich in fish biodiversity containing about 100-120 species in the pre-project condition as some of the Beels are perennial and retained water at higher depths mentioned above suitable for fishery. The fish diversity particularly SIS was also facilitated by the unregulated lateral migration from river to Beel and Beel to river during pre-monsoon breeding season. Thus Beel resident fishes, particularly 'SIS' were dominant in the Beels and floodplain. Moreover, the abundance of large-sized adult fish species (Rui- *Labeo rohita*, Catla- *Catla catla*, Lachchu- *Cirrhinus reba*, Ghonia- *L. gonius*, Boal- *Wallago attu,* Chital- *Notopterus chitala,* Shol- *Channa striatus,* Pabda- *Ompok pabda,* Boro Baim- *Macrognathus aculeatus,* Shar Punti- *Puntius sarana, etc.)* were also more. Furthermore, species were evenly distributed in the whole Haor system.

Post Project

Fish species diversity has the declining trend but in slow pace in the Post Intervention condition. This is happening may be due to many factors other than water control structures. The factors include habitat loss (both depth and area), water pollution, water regulatory structures, unplanned fisheries management, over exploitation of fish due to increase of fishers and modernization of fishing technology, indiscriminate fishing e.g. use of harmful fishing appliances, catching of post larvae and brood fish, complete dewatering of leased water bodies (less than 5 acres) for fishing, etc. In consequence of the above phenomena, following fish species become locally unavailable (for last 5-10 years) or have become rare includes Pabda, Boro Baim, Shar Puti, Chital, Boro Chingri (*Macrobrachium rosenbergii*), Nanid (*Labeo nandina*), Riverine Pangas (*Pangasius pangasius*), Rui, etc.

Impact

Comparing pre-and post project condition, it can be concluded that changes in fish species diversity and composition are not comprehensible in response to Project Intervention. Whatever changes in species diversity and composition between two phases are observed may be posed due to other anthropogenic factors mentioned above.

6.4 Fish Migration

Pre Project

Previously the Haor was hydrologically linked with the Shanir Haor and Tanguar Haor. For this reason, the abundance of large fishes like Rui, Catla, Ayer, Chital, etc. were more. Local fishers stated that the lateral fish migration was open through the natural connectivity during pre-monsoon. Furthermore, most of the fries of riverine fishes enter the Beels and floodplain along with flood water. However, successful lateral migration of different fishes e.g. riverine carps, catfishes, etc. at their certain stages of lifecycle for food and residence is happening due to sufficient depths of the Beels.

Post Project

Pre-monsoon (15 April – 15 May) spawning/breeding migration of riverine and Beel residence SIS fishes is mostly impeded through different connecting Khals due to water regulatory structures. Besides, riverine fishes migrate laterally to the Beels by overtopping or breaching of the existing embankment of the Haor during flooding months of Jaisthya-Ashar (15 May–30 June).

Pre-monsoon (15 April – 15 May) spawning/breeding migration of riverine (mainly the Baulai River) and Beel residence fishes through different connecting Khal is mostly impeded due to water regulatory structures. Besides, riverine fishes migrate laterally to the Beels by overtopping or through breaching points of the existing embankment during flooding months of Jaisthya-Ashar (15 May–30 June).

Impact

Comparing pre and post project conditions, it can be concluded that migration of SIS is impeded during the pre-monsoon in With Intervention condition and comprehensible impact has not been observed on fish migration in response to submergible embankment.

6.5 Fish Production Assessment

Pre Project

The estimated total fish production was 925 metric ton (MT) in 1989 where Floodplain shared the most about 64% followed by Beel and channel/Khal (Table 6.2).

Post Project

The estimated total fish production is about 3,025 metric ton (MT) in 2015 where floodplain shared the most about 80% followed by Beel, borrow pit, Baor, channel/Khal and fish pond as presented in Table 6.2. In the production assessment, the productivity of the corresponding year has been used.

Impact

Net increase in fish production in post-project condition is about 2,201 metric ton. As a whole, fish production has been increased by about 238%, whereas the floodplain production by about 360% and Baor by about 2403% (Table 6.2). Such huge increment in productivity may be caused due to adoption of fisheries management like Beel fishery, Beel nursery, increasing fishing activities, fishing commercialization, stocking of culture fish species in Beel fishery, etc. Moreover, the newly created habitat like borrow pit, Baor and fish pond have added 98, 75 and 23 metric ton of fish respectively. The breakdown of fish productions is presented in the following Table 6.2 by functional unit of fish habitats.

Table 6.2: Breakdown of Fish Production by Functional Habitat

Sl. No.	Habitat Category	Habitat Type	Production (MT)		Impact (MT) (Production Change)
			Pre-project, 1989	Post-project, 2015	
1	Capture Fishery	Channel/Khal	26	23	-3
2		Perennial Beel	299	160	-139
3		Floodplain	597	2,745	+2,148
4		Borrow Pit	-	98	+98

Sl. No.	Habitat Category	Habitat Type	Production (MT)		Impact (MT) (Production Change)
			Pre-project, 1989	Post-project, 2015	
		Sub-Total =	***922***	***3,025***	***+2,104***
5	Culture Fishery	Fish Pond	-	23	+23
6		Baor	3	78	75
		Sub-Total =	***3***	***101***	***+5***
		Grand Total=	**925**	**3,119**	**+2,201**

Source: Fish production assessment based on field findings and FRSS data, 1989 & 2015.

6.6 Fishing Appliances

Pre Project

Different types of fishing appliances are used to catch fishes. The mostly used fishing appliances are: gill net, Kona jal/Ghurni jal/Ber jal, push net, Khoira jal, hook, Kironmala (one type of trap used to catch Guraicha- *Leander styliferus*), Gui (one type of trap used to catch small fishes), Sip etc. Furthermore, illegal fishing practice was reported in the leased Beel. Dried up the whole Beel for harvesting benthic fish species may be considered as a good example of illegal fishing. However, this type of fishing depends on the leasing rotation system.

Post Project

Leaseholders (LHs) generally use Katha as fish aggregating device (FAD) for fish. LHs usually harvest fish annually. However, another type of fishing pressure has been increased day by day around the water control structures. The local fishers (particularly part-time fishers) create barrier at the mouth of water control structures by net for catching fish. This fishing pressure becomes more prominent during recession of floodplain water in the post-monsoon season.

Impact

The scheme is almost fully functional and possesses water control structures. For this reason, some deviation in fishing activities is found in response to Project intervention. Fishing is done at each of the water control structures which were absent in the pre project condition. On the other hand, fishing pressure is also increased with the increasing of fish demand and fish supply chain for both the national and global fish market.

6.7 Fishers Livelihood

Pre Project

Field findings reveal that about 20% of the Haor population were engaged in fishing and activities involved in fish supply chain for carrying out their livelihoods. Out of which about 5% were commercial fishers and the rest of them were subsistence level fishers. Commercial fishers spent annually about 180 days (6-8 hrs/day) in fishing.

Post Project

Presently about 80% of Haor population are engaged in fishing activities. The number of fishers are increasing day by day due to demand of Haor fishes as well as increasing of market price. Commercial and subsistence level fishers spend annually about 290 days (8-10 hrs/day) and 180 days (6-8 hrs/day) respectively in fishing. They mainly catch fish in the open water area in and around the Haor for carrying out their livelihoods. Furthermore, a number of part-time fisher groups are evolved and increased day by day for fishing at the mouth of the connecting Khals where there are water control structures.

Impact

It can be concluded that the number of part-time and subsistence fishers are increased in response to the Project interventions.

6.8 Fisheries Management

Pre Project

Beel fisheries with leasing system were the prominent fisheries management as reported from the local people. All Beels were harvested in the months of February and March. Beel fishery was more sustainable. However, there was no community based fisheries management in this Haor.

Post Project

Beel fisheries with leasing system are also the prominent fisheries management in the With Intervention condition. All leased Beels are harvested annually. The whole Beel is used to dry up for catching benthic fish species. However, this type of fishing depends on the leasing rotation system of the Government. Beel fishery is becoming less sustainable. There is a number of fisheries associations is a community based fisheries management in this Haor and no enforcement for limiting or controlling indiscriminate fishing at the water control structures.

Impact

Rotation length of time for fishing in most of the leased Beels is decreased from three-year rotation to one-year rotation in the with Intervention condition. Such over exploitation in conjunction with indiscriminate fishing at the water control structures is being happened mostly due to earn more money and driving fishery ecosystem into fragile resources.

7 Ecosystem

The Haor Basin in the north eastern part of Bangladesh is a wetland ecosystem considered to be of international ecological importance due to the extensive waterfowl population that uses the basin as its habitat. But its anaerobic conditions inhibit normal plant growth and only the plant groups known as hydrophytes which have adapted to thrive in such conditions. Halir Haor is one of the wetland ecosystems which support various types of ecosystems primarily terrestrial and aquatic. Terrestrial ecosystem belongs to different homesteads, kanda and roadside vegetations of the scattered settlement and their associated submergible roads. The remaining flora is aquatic life-forms. Similarly, a diversified fauna group along with aquatic species also occurs in this haor ecosystem.

7.1 Terrestrial Flora

Pre Project

Before 1964, the entire area was open and there was no protection of waves generated in the vast area of haor basin. In this situation, a few species who have the persistence to wave action during monsoon were Hijol, Koroch, and Mera. Other vegetation types especially herbs and shrubs regenerated during the post-monsoon were disappeared at pre-intervention period due to adverse wave actions.

Post Project

The post-intervention period after 1964, it has been the fortune to locals to save their property from a natural disaster like flooding. The haor area has been developed with interventions to harvest resources as per their need for a sustainable manner. The inhabitants have been planted different types of fruit, timber and medicinal plants in and around their home territory. The major trees were Mango, Coconut, Betel-nut, Acacia, Mahogany, and Kodom. The periphery of the homestead has been well protected by Barun, Hijol and Koroch trees. In addition, these latter two species occur scattered throughout the haor area. Most of the submergible roads along with their slopes are occupied with Dhol Kolmi and Murta those act as protective vegetations and useful as fuelwood of this area.

Impact

The interventions like the construction of embankment, installation of regulator and improvement of drainage systems have paved the way to enhance the diversity of flora. But the population density and their daily needs are downing the current status. Access to more people to harvest natural resources as per demands has been leading depletion of terrestrial floral coverage due to overexploitation. Therefore, the ultimate goal of the interventions was dismay. The specific impact on flora has been depicted below in Table 7.1.

Table 7.1: Overall Status of Terrestrial Flora of Halir Haor

Indicator Species	Pre project	Post project	Cause of status change
Pitali/Mera	Common	Decreasing	Population density and human-induced pressure
Hijol	Common	Decreasing	Population density and human-induced pressure
Koroch	Common	Decreasing	Population density and human-induced

Indicator Species	Pre project	Post project	Cause of status change
			pressure
Barun	Common	Common	Not applicable
Dhol Kolmi	Common	Very Common	Cultivation for fuelwood, Suitable habitat and adapt soil quality
Nol Khagra	Common	Rare	Agricultural expansion, Population density and other human-induced pressures

7.2 Terrestrial Fauna

Pre Project

The overall condition of the terrestrial fauna was in good. Most of the terrestrial fauna found very common. In this stage, the mammals such as porcupine, wild buffalo, wild boar etc were the target for hunting. The other species had no to face such ordeal situation in terms of survive. Before 1964, Brahminy Kite, Pallas's Fish Eagle, and Bull Frog population were abundant in this area.

Post Project

At the post-intervention era especially after 1964, the fauna status had been declining for decades. Most of the dominant terrestrial fauna drop into threatened category due to anthropogenic pressure (hunting and disturbance). After implementation of interventions, it had paved the way to produce more crops instead keep lands unproductive. In this context, the fallow land/kandas and other swamp forest had been converted into agricultural land to produce rice. As a consequence, terrestrial fauna lost their suitable habitats where they build nests, groom for breeding and take parental care to their offspring. Most of the species was common to rare in the case of threatening through anthropogenic pressure e.g. population density. On the other hand, introduction of pesticide has given the privilege to accelerate their population risk to extinction. In this way, the population size and diversity of the existing species have gone down.

Impact

The facilities provided by the intervention namely embankment, sluice gate, regulators, etc has given the opportunity to other sectors for harvesting best service but it has been triggered fauna into diminishing to the threat of extinction. The Pallas's Fish Eagle, Fishing Cat, and Vulture received threat in vanishing near future. A specific status of the terrestrial fauna is presented in Table 7.2.

Table 7.2: Intervention Impact on Terrestrial Fauna of the Halir Haor

Indicator Species	Pre project	Post project	Cause of status change
Pallas's Fish Eagle	Common	Rare	Expansion of human settlement and cutting of tall trees
Brahminy Kite	Very Common	Common	Disturbance by human, reduction of fish population
Vulture	Common	Rare	Using of medicine in livestock sector
Bull Frog	Very Common	Common	Agriculture extension, insecticide uses
Fishing Cat	Rare	Rare	Not applicable
Bengal Fox	Rare	Common	Expansion of agricultural land as Suitable habitat
Monocellate Cobra	Common	Occasional	Habitat loss, hunting

7.3 Aquatic Flora

Pre Project

Before 1964, the total Halir Haor area was open in pre project situation. The floral vegetation like water hyacinth and water lily were with abundant because most the land was fallow not to use for cultivation. Sometimes, flash floods occurred and made damaged to many floral communities. The diversity of flora in this haor area was good enough compared to current status. Additionally, the population density was also standard in this haor ecosystem.

Post Project

After implementation of interventions, it paved the way to boost up agricultural production throughout the study area. Large-scale settlement was initiated at the mid-20th century from surrounding densely populated regions and since then the resources of the haor basins are being exploited at an increasing rate causing adverse effects. Continuous large-scale exploitation of aquatic vegetation and fruits like Makna (Euryale ferox), Singara (Trapa bispinosa), Lotus, Lily, Hogla (Typha elephantina) has caused serious degradation of the quantity and quality of the habitat required for fish and migratory birds of the haor areas. As a consequence, most of the arable land was considered under cultivation and most of the kanda had been barren for a long time which is now considering for crop cultivation. For such practice, most of the aquatic vegetation has disappeared for decades.

Impact

The interventions for raising crop productivity have a major impact on aquatic flora throughout the haor area. Some species has lost its richness and received threats to its survival namely Water Lilly, Makhna, and Chhaila Grass. A detail specific status of the aquatic flora is presented in Table 7.3.

Table 7.3: Status of Aquatic Flora of the Study Area

Indicator Species	Pre project	Post project	Cause of status change	Type of Intervention that caused the change (If Yes)
Kochuripana	Common	Common	Not applicable	-
Shapla	Common	Rare	Overexploitation, fishing activities	Not applicable
Makhna	Common	Disappeared	Over exploitation	Not applicable
Singara	Common	Disappeared	Over exploitation	Agricultural extension
Chhaila Grass	Common	Decreasing	Over exploitation	Agricultural extension and herbicide use

7.4 Aquatic Fauna

Pre Project

The haor area was land for aquatic bird including migratory for a long time. Among the resident wildlife, Little Cormorant, Little Egret, Great Egret, Cattle Egret, Pond Heron, Checkered Keelback, Skipper Frog, and Indian Bullfrog were abundant. In the past, the anthropogenic pressure was low compared to the current decades. Of the aquatic mammals, the Ganges River Dolphin and Eurasian Otter had been regular in this haor.

Post Project

The haor land was a very lucrative destination for the water birds as well as waders in this area. But facilitate by the interventions for boost up crop production has decreased their feeding habitat by cultivating rice in the floodplains, beels and other low lands of their feeding habitat. In addition, the generated noise from tractors and other cultivation machinery made disturbance to waders throughout the area. The hunting pressure also can be mentioned as disturbance to avoid the feeding ground by the birds. Moreover, the practice of pesticide use in the paddy field has caused decreasing the population of the aquatic fauna. Due to the implementation of interventions throughout the haor it triggers the diminishing of their population as well as diversity for decades.

Impact

By implementing interventions throughout the haor area it stopped the passages of the aquatic mammals namely the Ganges River Dolphin and Eurasian Otter. Moreover, diminishing feeding area through cultivation practice has reduced the feeding ground of aquatic fauna especially waders include migratory birds in this region. The hunting pressure is one of the reasons for decreasing aquatic birds' presence in this area. Establishment of embankment around the haor has stopped the access of Ganges River Dolphin and Eurasian Otter in this haor. A detail impact of the interventions has been provided below in Table 7.4.

Table 7.4: Aquatic Fauna Status of the Halir Haor

Indicator Species	Pre project	Post project	Cause of status change	Type of Intervention that caused the change (If Yes)
Indian Bullfrog	Very Common	Common	Agricultural extension	Embankment
Monocellate Cobra	Common	Rare	Use of pesticides, hunting	Not applicable
Indian Roofed Turtle	Rare	Disappeared	Agricultural extension and hunting	Not applicable
Migratory Birds/Waterbirds	Very Common	Squeezing	Agricultural extension	Not applicable
Eurasian Otter	Common	Disappeared	Agricultural extension	Not applicable
Ganges River Dolphin	Common	Disappeared	Human-induced pressure	Embankment

7.5 Swamp Forest and Reedland

Pre Project

A good number of swamp forests and Reedlands were occurred inside the haor for long decades. The composition of reedlands is Baro Nal (Arundo donax), Khagra (Phragmites karka), Murta (Schumannianthus dichotomous), Chitki (Phyllanthus disticha), etc. The forest density was good enough to sustain and support to different fauna. In addition, the kandas of the beel also been occupied with different reeds and associated jungles for a long time. In this way, the reed lands provided habitats to different wildlife species for nesting and roosting for a while. It also provided core habitats to wildlife in this haor region.

Post Project

The swamp forests, which were once dominant with the flood-tolerant tree species like Hijal (Barringtonia acutangula) and Koroch (Pongamia pinnata), these are currently reduced to a few small patches. The haors are also important fishing grounds of the country. In the past century or so, when the population pressure was less, most of the marginal lands of the haors remained as cultivable wasteland and was used for extensive grazing in the dry season. The peripheries of the pastures are occupied with reed a land with broken-down forest cover seems to be disappeared less than a decade.

Impact

Degradation of wetlands has caused several problems including extinction and reduction of wildlife, loss of many indigenous aquatic plants, herbs, shrubs and weeds, loss of natural soil nutrients, loss of natural water reservoirs and of their resultant benefits, increase in the occurrence of flooding and degradation of wetland-based ecosystems. Wetlands are dynamic ecosystems, which change over a long time. Despite protection from external threats, it may die a natural death through heavy siltation, changing river courses, etc. Keeping this in mind, the transformation of wetlands through human intervention must be undertaken carefully.

7.6 Ecosystem Goods and Services

Pre Project

The ecosystem goods are fertilizer, food, medicine, energy, fiber, construction and craft material. On the other hand, the ecosystem services have been divided into four categories on the basis of their nature of functions and they are provisioning, regulating, supporting and cultural services. In this stage, the goods and services had not interrupted by any interventions and these are improved naturally. The provisioning services in this area had been considered as food, medicinal plants and genetic resources of the flora and fauna had been standard before implementation of the interventions. Regulating services such as climatic condition was good because of vast coverage of natural vegetation. Wetland function was good due to absent of different types of physical structures. In addition, the cultural services like spiritual, religious, and recreational and ecotourism, aesthetic, educational and cultural heritage also be considered as optimum.

Post Project

The provisioning services have been changing day by day due to the implementation of interventions throughout the haor area. The change implies rice variety changes from local to HYV and the introduction of other vegetations which occupied largely throughout the haor area. The regulating services also interrupted via climatic change while wetland function and habitat became worse. The cultural services have also been changed. It practices tourism instead of ecotourism and hampering the aesthetic value of the haor area.

Impact

Of the above-mentioned three ecosystem services changes occurred negatively in food, medicinal vegetation and diversity, and population of flora and fauna of the depicted haor area. Similarly, unplanned tourism establishment, also an event, occurs within the haor ecosystem.

8 Socio-economic Conditions

8.1 Introduction

The Haor system provides a wide range of economic and non-economic benefits to the local people as well as other people of Bangladesh. This is (Haor) an important source of agriculture, commercial fishing, livestock and poultry rearing, collection of reeds and grasses, collection of aquatic and other plants. The socio-economic scenario was explored in this section to understand both before and after project people's condition using both primary and secondary data in relation to the objectives of the study.

8.2 Location and Population

This study is conducted at the Halir haor region which is located at the Jamalganj upazila under the sunamganj district in sylhet division. In Jamalganj upazilla, there are six mouzas (6) under the Jamalganjsadar union and thirty two (32) mouzas under the Behli and Sachnabazaar union. Following table 8.1 shows the union wise population of this study area based on Bangladesh population and housing census 1991, 2011 and projected population in 2017.

The Population and housing census data 1991 shows the number of population during the intervention. The population and housing census data 2011 and projected population data in 2017 depicted the change in population in the study area during the period.

Table 8.1: Union wise population of the study area

District Name	Upazila Name	Union Name	Total Population in 1991	Total Population in 2011	Projected Population in 2017
Sunamganj	Jamalganj	JamalganjSadar	30482	51604	105222
		Sachna Bazar	14279	26049	
		Beheli	14648	19320	
Total Population			**59409**	**96973**	

Source: Bangladesh Population and Housing Census 1991 & 2011.

8.3 Livelihood Status

Pre Project

Agriculture was the prime source of livelihood for the majority of population. Production of crops yielded them their food and cash money. The livestock, forestry and fisheries were the secondary sources of income. In addition, other sources of income were non- agricultural labor, business and employment.

Post Project

The primary livelihood (agriculture) remaining almost the same as before, its environment has improved with higher yields and less damage to crops. The second major livelihood (fishing) has experienced twofold impacts: (i) open fishing opportunity has been restricted due to less movement of fish into embanked area even after submergence and (ii) the poor part time or full time fishers who used to fish before project feel psychologically restricted to fish in embanked area due to a spell of project control. Besides these, livelihood opportunity for wage labour has increased in agriculture. Overfishing from the haor and siltation of riverbeds have recently caused reduction of fish resource, thereby causing loss of livelihood opportunity for the poor.Halirhaor, its water body, by and large, has still remained the major source of livelihoods for the people of the locality.

Impact

Agriculture is the main sources of income so far and the agricultural production is increasing in Halir haor area. Income opportunity based on fishing has declined and only some people from fishing community got access only to do work as a seasonal labor in this particular area. Due to leasing arrangements, which are often controlled by local elites, result in highly restricted access to open water fisheries by the poor.

8.4 Accessibility in Education and Health

Pre Project

Before intervention, the health and education for the people of Halir haor region were not accessible to all. During the rainy season, primary education is frequently disrupted during floods almost every year. People used to use boat to go both schools and health institution while walking was the main way to go at the remote schools and health institutions some partial infrastructural damage often happens. Schools are remaining closed for 70 days in average every year due to flooding as well as the buildings are used as shelter place for the affected people. On the other hand, students living in distance area usually drop their classes due to unsafe communication during monsoon. On the other hand, the flood induced poverty increases the number of drop-out students in this haor. Nevertheless, proper flood protection may improve children's schooling opportunities and increase the overall literacy as well.

Post Project

With the period of time, the health and educational institutions have increased and people especially school going children have become enthusiastic to go to schools through different Govt. and NGOs programs. Besides, when the submergible embankments were constructed, local people, school going children, pedestrian, women and other people got the way easy by the use of these embankment's alignment (*Ayle*) especially in the dry season. Presently, when some of the locations of the embankments were damaged, people's way to reach to the schools and health institutions are reported to be hampered for a certain period. But in wet season, deferent types of boats are the main sources of transportation for going school and health center.

Impact

With the period of time, the health and educational institutions were increased and people especially school going children were become passionate to go to schools through different Govt. and NGOs programs. Besides, with the establishment of embankments local people, school going children, pedestrian, women and other people got the way easy by the use of this embankment's alignment (*Ayle*) especially in the dry season. Presently, when some of the locations of the embankments became damaged, people's way to reach to the schools and health institutions were being hampered in which people of the HalirHaor suffer mostly for a certain time being.

8.5 Land Price

Pre Project

Before intervention, the land price of this haor region was minimal and people were not interested to buy land due to regular flash flood and crop damage. It is reported by local people that the price of agricultural land was 8000 to 9000 Tk per Keyar[1] and Tk.12,000 to Tk. 15,000 for homestead land before project.

Post Project

With the change and autonomous development in the whole haor region this situation has changed and the land price has increased with the period of time. After the project intervention, the land price has increased due to the increased productivity of land. Though exogenous factors like macroeconomic development and inflation have contributed to raise the land price, people's interest to buy those land acknowledged to be one of the reasons of rise in land price. Presently, the price of agricultural land is near to be 1.5 lakh to 2.00 lakh whereas that of homestead land is Tk. 2.0 lakh to 3.0 lakh.

Impact

Presently, the price of agricultural land per Keyar (30 decimals) is around BDT 1.5 lakh to BDT 2 lakh whereas the price of homestead lands learnt as BDT 2 lakh to BDT 3.0 lakh.

8.6 Agriculture Based Income

Pre Project

Livelihood opportunities for households in the Halir haor region were limited and highly seasonal, as they were focused predominantly on agricultural labour associated with the single annual rice cropping cycle. Fishing was traditionally an important occupation for the people of haor region. The incidences of livestock husbandry as a livelihood activity in the haor region were also prominent as their tertiary source of income before the intervention.

Post Project

After project intervention, the income opportunity based on agriculture increased and people got chance to grow more paddy and recruit local labor, generating extra income opportunities for the wage earning households. People who have more land can grow more crops after the project.

Following table 8.2 shows the agricultural income based on land ownership stratum. Based on current production rate (per decimal), agricultural income has been calculated and presented in this table. According to this table, the category of landless people did not get opportunity in both before and after project situation. Marginal farmer category (farmers who own 1-49 decimal land shows a 10% rise in population (25% before and 35% after project) with proportionally larger income with project. The reason is learnt to be a proliferation in this category entering from small farmer group who sell out land to owners of upper categories due to high cost of production they cannot afford. Even they become landless when they sell all their land for sustenance. Hence is the increase in absolute landless group by 5%.

[1] 1 Keyar = 30 decimals

Table 8.2: Agricultural Income Based on Land Ownership Spectrum in Halir Haor

Land Ownership Stratum	Households (%)		Income (agriculture base)	
	Base Conditions	After Project	Before Project (BDT)	After Project (BDT)
Absolute Landless(0 ha)	10	15	-	-
Functional Landless and Marginal farmer (0.004 – 0.198 ha)	25	35	5840	6376
Small farmer (0.202 - 1.008 ha)	45	25	34925	38129
Medium farmer (1.012 – 3.032 ha)	10	15	116689	127394
Large farmer (3.036 ha and above ha)	10	10	156195	191283

Source: Field data, 2017 through FGD, KII, and Informal Interview

The increased income of different land-size groups due to project interventions. Standard five land size categories have been used and net increase in yield of rice crop due to improved cultural environment is shown.

Table 8.3: Net Increase in Agricultural Income by Category of Land Owners in Halirhaor

Land Ownership Stratum	Average size of land (ha.)	Increased Yield/ha (ton)	Total Increased Production (ton)	Price/ton (Tk)	Total Additional Income (Tk) gov. As per government procurement rate
Absolute Landless(0 ha)	0	0	0	0	0
Functional Landless and Marginal farmer (0.004 – 0.198 ha)	0.101	1.6	0.1616	21400	3458.24
Small farmer (0.202 - 1.008 ha)	0.605	1.6	0.968	21400	20715.2
Medium farmer (1.012 – 3.032 ha)	2.022	1.6	3.2352	21400	69233.28
Large farmer (3.036 ha and above ha)	6.518	1.6	10.4288	21400	223176.32

Impact

Regular flooding and water logging condition, especially during the March-April (time of *Chaitra* and *Baishakh,* Bengali Month), used to damage agricultural production very often before the project and therefore, the income opportunity of agricultural households declined. The opportunities for agricultural labor were also limited during the time of before project condition for the same reason.

After project intervention, people got enabling environment to grow more paddy and recruit local labor generating extra income opportunities. So the income opportunity based on agriculture has increased with project. People who have more land can grow more production during the project period.

8.7 Income of Agricultural Wage Labor

Pre Project

It was found that net demand for labor per ha near about 130 (for local Boro) and most of the labor came from outside than the locality.

Post Project

After intervention, the total crop and cropping pattern has been changed. Regarding this situation, the net demand for agricultural labor (having with technological innovation) has been increased than before. The demand of agricultural labour is near about 160 (for HYV Aman, Hybrid Boro, and HYV Boro) per ha whereas most of the labor come from the local areas. The income rates of labor from other regions were being increased after the time of project intervention. In this way, BDT 235.68 lac agricultural wage labor income increased with the period of after project.

Impact

Regular flooding and water logging condition especially during the time of *Chaitra* and *Baishakh* (Bengali Month) inflicted damage to agricultural production before the project and, therefore, the income opportunity of agricultural households declined. The opportunities for agricultural labor were also limited during the time of before project condition.

After project intervention, people got enabling environment to grow more paddy and recruit local labor generating extra income opportunities. So the income opportunity based on agriculture has increased Post-project. People who have more land can grow more production during the project period.

8.8 Labor and Seasonal Migration

Pre Project

Before intervention, people did not get more access to do other works than the agriculture. People from different regions came to join as work force for crop harvesting and fishing labors. The intensity to come during that period was significant and people's demand specific labors within the haor area were not adequate to assist their agricultural production. The technological innovation for agricultural production was not significant at that period and all activities related to agricultural production were physical labor basis. It was found that net demand for labor per ha near about 130 and most of the labor came from outside than the locality.

Post Project

After the project intervention, as the agricultural production has increased, therefore, it is easily estimated that livelihood opportunity for wage labour has increased. The net demand for agricultural labor (having with technological innovation) is near about 160 per ha. About 40% labours come from other regions is higher than before. In a cropping season when the working opportunities are available, people rarely migrate outside of their habitat and instead in-migration takes place during that time. Furthermore, during last ten years people were facing regular damage due to flood and water logging, in this way, people those who were defendant on agriculture were forced to migrate neighboring districts for better livelihood and as a lack of employment opportunity. During the flash flood, people of this halirhaor try to find other opportunity to do work as motor driver, garment workers, rickshaw puller in Sylhet and Dhaka city areas.

Impact

After the project intervention, as the agricultural productions were increased, therefore, it is easily estimated that the demand for labor would have to be increased. However, regarding this situation, the net demand for agricultural labor (having with technological innovation) is near about 160 per ha whereas most of the labor come from the local areas. The incoming rates of labor from other regions were being increased as the increase agricultural production after the time of project intervention.

8.9 Transport and Communication

Pre Project

Before intervention, people mostly used boat during the rainy season, and specific transportations system was not available during that period. People used to go to their desired places on foot in the dry season. The roads for using any kinds of vehicle were not available. Most of the social occasions were held during rainy season only to avail opportunities of using boats.

Post Project

After the period of project intervention, people started to use those submergible embankment as road to go to school, highways, bazaar and health center etc. Though those embankments were not suitable for driving automobiles, people got opportunity to ply with auto rickshaws and bikes during the dry season. But in wet season, boat is the main sources of transport and communication in this region.

Figure 8.1: Submergible Road and an Embankment Road that Also Used as the Means of Communication

With the period of time, mostly in the last 5 to 10 years, the damage of those submergible embankments were become crucial and school going students, pedestrians, children and women were facing problems to use those embankment as the their walking ways during the early monsoon period.

Impact

The communication has improved over the pre-project situation due to its proximity to the Jamalganj upazila sadar. The BWDB's submersible and compartmental embankments are playing main role in communication across the haor. This has expedited the transportation of goods and harvests too far off places at low cost. Moreover, accessing schools and clinics has become relatively easier for children and patients along the embankment at least when flood water recedes.

8.10 Institution and Governance

Pre Project

Bangladesh Water Development Board (BWDB) was responsible for physical implementation of water sector projects in haor region. Of late, Department of Haor and Wetland Development has been created. As apex institutions, these two have been administering all plans and projects in haor region.

Before the project intervention, local government organization like Union Parishad or Thana Parishad existed with mandate to look after haor water resources. Regular inundation by flood waters was almost a regular phenomenon in haor area. Leasing of Jalmahals was the prime activity of those institutions for raising revenue of the government. It was only after BEDB was created that the issues of water development came in.

Post Project

After the project implementation, Water Development Board started to develop, manage and monitor the project activities in Halir haor. Their role for operation and maintenance was regular with the completion of submergible embankments. Presently, it has been found from the consultation with primary stakeholders that those institution are visible only during the period of damage and to monitor the physical condition of those embankments after the flooding condition. According to the local people, the officials from this institution t do not consult with the local people for lessening the damaged area of those submergible embankments.

Impact

The presence of BWDB and the Water Management Group has some institutional impact on the beneficiaries of the haor project. Overseeing the operation and maintenance of the infrastructures is the main function of those institutions. But the condition of physical infrastructures of the haor is reported to be running below the desired level

8.11 Accessibility in Health and Educational Institution

Pre Project

Before intervention, the health and education services for the people of Shanir Haor Project area were not accessible to all. During the rainy season, primary education was frequently disrupted during floods almost every year. People used boat to go to schools and health clinics while walking was the only choice when boat could not ply. Schools remained closed for about 70 days on average every year due to flooding. The school houses were used as flood shelter for the affected people. On the other hand, students living in distant area usually used to drop their classes due to unsafe communication during monsoon. Besides, the flood- induced poverty increased also the number of drop-out students in this haor area.

Post Project

Health and educational institutions (both in number and services) have increased with time; and people, especially school going children have become enthusiastic to go to schools run under different Govt. and NGOs programs. Besides, since the submergible embankments constructed, local people, school going children, pedestrian, women and other people have been using it as road especially in the dry season. Presently, when some of the locations of the embankments are damaged, people’s way to reach to the schools and health institutions are reported to be hampered for a certain period. But in wet season, deferent types of boats are the main sources of transportation for going to school and health center.

Impact

Direct impact of the construction of Shanir Haor Project area on literacy and health is marginal, but indirectly, the submergible embankments are serving as road to for getting easy access to schools and clinics during the dry period. Patients on emergency can be taken to clinics by using local vans or rickshaws along the embankment in dry season as alternative roads are not existing. The indirect benefit to education and health services is the increased affordability of small and medium farm households to avail those services with their increased agricultural and ancillary income due to protected crops and other resources from damage as an effect of early flood control and drainage infrastructures.

9 Summary of Impacts

Table 9.1: Summary of Impacts

Indicators	Pre project	Post project	Impact
Water Resources			
Flooding situation	Before implementation of the project, the haor was open and flash flood water frequently entered into the haor during mid-March to early April.	After implementation of submersible embankment and closures in Halir haor project by BWDB in 1988, entrance of flash flood into the haor got delayed by 8 to 12 days. At present, the embankment is lower than the design level.	Interventions of the haor has reduced the risk of earlier entrance of flood and saved the crops from damage. However, due to lower level of the embankment than the design, flash flood frequently enters.
Drainage condition	Most of the flood water could smoothly be drained out to the peripheral rivers through the drainage khals and only some water got retained in the low-lying beels.	The drainage of the haor has little bit been deteriorated. It got delayed by 7 to 10 days than pre-project period.	The drainage of water of the area has become slower than before.but not impacted appreciably.
Sedimentation and siltation	Sedimentation in this haor was not that much problem before implementation of the interventions.	Sedimentation has taken place in the river and khals over the years by about 1-1.5 inch. As a result the bed level of the peripheral rivers and khals has risen and reduced their conveyance capacity has been reduced.	Siltation process is natural here. it has not changed largely than pre-project condition.
Navigation	During monsoon navigation is the major mode of communication of the local people.	There are no significant changes in navigation before and after the interventions. However, communication system has improved tremendously in dry season, due to construction of submergible embankments.	There is no significant changes in navigation after implementation of the interventions rather number of vessel if increased.
Land Resources			
Land use	▪ Gross area: 8,774 ▪ NCA:5,759 ▪ Others:2,702	▪ Gross area: 8,774 ▪ NCA:6,741 ▪ Others:1,697	▪ i)NCA:+982 ▪ ii)Others:-1005
Land degradation	No	No change	No change
Agriculture Resources			
Cropping intensity (%)	100	100	No change
Cropped area (ha)	Rice: 5,759 (Boro: 5,760) Non Rice: 0	Rice: 6741 (Boro: 6740) Non Rice: 0	Rice: +982 (Boro: +980) Non Rice: 0
Crop production (ton)	Rice: 18,935 (Boro: 18,935) Non Rice: 0	Rice: 29,643 (Boro: 29,640) Non Rice: 0	Rice: +10,708 (Boro: +10,710) Non Rice: 0
Crop damage (ton)	Rice: 3,646	Rice: 8,746	Rice: +5,100

Indicators	Pre project	Post project	Impact
	Non Rice: 0	Non Rice: 0	Non Rice: 0
Irrigated area (ha)	Rice: 5,760 Non Rice: 0	Rice: 6,740 Non Rice: 0	Rice: +980 Non Rice: 0
Surface water Irrigation availability	Available	Deficit during month of February to March	Deficit
Agro-chemicals use (ton or kiloliter)	Fertilizers: 333 Pesticides: 0	Fertilizers: 1,694 Pesticides: 1.39	Fertilizers: +1,361 Pesticides: +1.39
Livestock Resources			
Livestock population (number)	Cattle: 18,510, Goat: 1,560, Chicken: 34,310 Ducks: 32,300	Cattle: 23,790, Goats: 1,110, Chicken: 42,440 Duck: 24,640	Cattle: +5,280, Chicken: +8,130 Goat: - 450 Duck: - 7,660
Fisheries Resources			
Fish habitat area	• Total fish habitat area- 8,239 ha • Habitat area breakdown: ○ Khal- 115 ha ○ Beel-667 ha ○ Floodplain- 7457 ha ○ Baor-13 ha	• Total fish habitat area- 8,191 ha, • Habitat area breakdown: ○ Khal- 68 ha ○ Beel- 148 ha ○ Floodplain- 7842 ha ○ Borrow Pit- 65 ha ○ Fish Pond- 9 ha ○ Baor-59 ha	• Loss of total fish habitat area by 61 ha (contributed by loss of Beel and Khal area)
Fish habitat condition	• Habitat quality and suitability condition was in favor of fisheries; • Maintained unregulated ecosystem with better provisioning (i.e., fish) and supporting (i.e., fish nursery and breeding grounds) services like sustainable fisheries.	• Habitat quality and suitability condition becomes little degraded; • Regulated ecosystem with somewhat degraded and unsuitable habitat condition particularly for Beel resident fishes; • Increased pollution load due to intensified Boro cultivation.	• Slightly degraded habitat condition driving towards relatively less sustainable mentioned provisioning and supporting services.
Fish Diversity	• More or less evenly distribution of fish species over the area.	• Abundance of some biologically and commercially important fish species become low or rare locally; • Large fish population like Notopterus chitala, Labeo calbasu, Labeo rohita, etc. and Bottom feeder fish species like Clarius batrchus, Channa punctatus, Macrognathus aculeatus, etc. become affected more due to dewatering of Beels and indiscriminate fishing in Beel leasing system; • Increased abundance of SIS fish species.	• Little imbalance in fish species distribution over the area; • Vulnerability to Beel resident fish species; • Possible inbreeding problem due to increase of culture exotic fish species.
Fish migration	• Unregulated lateral fish migration from	• The scheme is almost fully functional. For this	• There is significant implication of

Indicators	Pre project	Post project	Impact
	river to floodplain and vis-à-vis through Khal; • Regulated lateral fish migration from internal Khal to Beel and vis-à-vis by making earthen closure at the mouth of Khals by Beel Leaseholders (LH).	reason, fish migration from river to Beel and Beel to river in the pre-monsoon season is being obstructed due to embankment and water control structures.	interventions on fish migration particularly for SIS.
Fish production	• Fish production in 1989 was about 925 metric ton.	• Fish production in 2015 was about 3,119 metric ton.	• Overall fish production gain is about 2,201 metric ton in 2015 compared to production of 1989.
Fishing Appliances	• Sustainable fishing was done using suitable mesh sized fishing gears. • Use of Kona jal /Mosquito net (small mesh sized net) was not reported. • Fishing pressure at the mouth of the Khals during recession period were very low except leased Beel connecting Khals (only by LH).	• Unsustainable fishing is being done using small mesh sized fishing gears like Kona jal /Mosquito net (mesh size in mm); • Fishing pressure at the water structure points during recession period is more because of engagement of mass people.	• Increased use of unconventional fishing appliances and thus increased fishing pressure.
Fishers Livelihood	• Commercial fishers were dominant in floodplain fish habitat meaning livelihood fully dependent on fishing. • Fishing people were less.	• Part-time fishers become dominant in floodplain fish habitat meaning carrying livelihood with fishing is not adequate and need other income generating activities. • Fishing people are more.	• Fishing based livelihood of commercial fishers becomes unsustainable due to dominancy of part-time fishers.
Fisheries Management	• Beel fishery maintained three-year rotation in harvesting fish; • Fish got more time for propagation and grow up; • Sustainable fishery.	• Beel fishery is being maintained mostly one-year rotation in harvesting fish. • Fish is not getting enough time for propagation and grow up; • Unsustainable fishery.	• Beel fishery is being secured by the scheme though the weak enforcement is not yielding expected benefit.
Ecosystem			
Terrestrial flora	Indicator species were common	Reduced population	Pitali, Hijol, Koroch and Nolkhagra have been decreased due to agricultural and human settlement expansion
Terrestrial fauna	Status was common for most of the	Status have been changed and population	Reduced population of Pallas's Fish Eagle,

Indicators	Pre project	Post project	Impact
	indicator species	decreased	Vulture and Monocellate Cobra
Aquatic flora	Indicator species were common	Status have been changed	Reduced Water Lilly, Makhna, and Chhaila Grass
Aquatic fauna	Indicator species were common	Status have been changed and number of population has been dropped	Indian Roofed Turtle, Ganges River Dolphin, and Eurasian Otter has disappeared; Reduced population of Monocellate Cobra and migratory birds
Swamp Forest and Reedland	Optimum	Vulnerable	Reduced biodiversity regarding the swamp forest and their vicinity Nolkhagra have been rare due to conversion of reedland
Ecosystem goods and services	Optimum	Reduced	Provisional services has boosted up and regulating and cultural services has reduced
Socio-economic Conditions			
Employment Opportunity	• Total cropped area was 5,759 ha whereas about 130 man days labour (per hector) inputs were needed.	• Total cropped area were 6,741 ha where about 160 man days labor input were needed (technological use)	• Employment opportunity has been created during the period of operation and maintenance of those projects in Halir Haor • New employment opportunity had been created with the increase of agricultural production
Labor and Seasonal Migration	• People from different regions came to join as work force for crop harvesting and fishing labors. • Before intervention, people mainly engaged in agriculture. • The Net demand for labor per ha near about 130 in the basis of agricultural production.	• The net demand for agricultural labor (having with technological innovation) is near about 160 per ha in the basis of agricultural production.	• The demand for labor would have to be increased. • The technological innovation in agriculture was increased that increased the labor demands simultaneously. • The net demand for agricultural labor (having with technological innovation) is near about 160 per ha whereas most of the labor come from the local areas. • The incoming rates of labor from other regions were being increased after the time of project intervention.
Agriculture and wage base income	• The total agricultural production base average income were about BDT	• The agriculture production base income after the period of after project is about BDT	• Agricultural production base income was increased due the project intervention.

Indicators	Pre project	Post project	Impact
	1,094 lakh • The agricultural wage base average income was about 7.5 lakh.	1,636 lakh • The agricultural wage base average income is 10.8 lakh	• Agricultural wage labor income increased during the period of after project condition.
Land Price	• The price of agricultural land was 8000 to 9000 Tk per *Keyar*	• The price of agricultural land is near to be 1.5 lakh to 2.0 lakh whereas the price of 2.0 lakh to 3.0 lakh for homestead lands.	• The opportunities for agricultural production were increased in which the value of agricultural lands was being increased with the period of after project condition.
Accessibility in Health and Educational institution	• It was tough to go to the schools and health institutions especially in the dry season.	• People started to use the embankments as their way of communication. • With the damage of the certain locations of the embankments people felt unsecured to use their way of moving during the rainy season. • School going children sometimes fall in problem in using embankments as their way to go to schools.	• The communication system became easier after the time of project intervention. • Due to lack of proper maintenance, the damage of the embankments was increased and local people started to face problem to use these embankments as their means of communication.
Institution and Governance	• There was no institutional governance as there was no intervention (i.e. Submergible embankment)	• The institutions (i.e. WDB) started to work and monitor the damage during the post flooding time. • The Governance had the gap from the corners of local people. • There was no participation with the local stakeholders from policy to implementation	• The practice of good governance is unavailable that lead to increase damage of those embankments • There is no mechanism to understand local people's concern in terms of project operation and maintenance. • The role of institution to consider public demand in policy, operation and maintenance on the issue of those submergible embankments.

10 Environmental Management Plan

Table 10.1: Management Plan

Impact	Mitigation Measures	Enhancement Measures
Flooding	• The submersible embankment should be repaired as per design section. • The construction and repair work of the embankment should be monitored properly and timely, particularly within February • The embankment should be raised by 3 feet at certain places where the level is lower than the design level.	
Drainage	• Internal khals and peripheral rivers should be re-excavated as required. • Proper slope and connection of local channel with inlet and outlet should be ensured	
Sedimentation	• Sedimentation from the bottom of the regulators and sluices should be removed. • The surrounding rivers and channels should be re-excavated	
Navigation	• Some ghats should be constructed at suitable locations and some navigation friendly culverts should be constructed over the embankment. • Causeway should be constructed at suitable locations to minimize public cut.	
Increased cropped area		• Khanda should be utilized for vegetables cultivation. • Hydroponics or floating bed vegetables cultivation should be introduced or strengthened. • Medium high and medium low land should be utilized for short duration T Aman cultivation. • Flood tolerant submergence variety (BRRI dhan51, BRRI dhan52 and BRRI dhan79 may be tested.
Increased crop production		• Crop area should be increased by utilization of fallow land. • Short duration high yielding and hybrid varieties should be developed/introduced/strengthen ed. • Crop damage should be minimized by timely and proper rehabilitation of water control structures like embankment,

Impact	Mitigation Measures	Enhancement Measures
		regulators, drainage sluices etc.
Increased irrigated area and Availability of irrigation water	• Regular re-excavation/dredging of the Baulai, Nawa, Surma and Kanai river has to be ensured in order for retention of irrigation water.	• Re-excavation of existing beels and khals should be ensured for retention of irrigation water. • Irrigation water should be ensured by stopping drain out the beels during early dry season for fish harvesting.
Status of livestock/poultry		• Grazing area should be increased by utilizing fallow land. • Awareness build up through training • Marketing facilities should be improved. • Availability of high yielding breed should be ensured.
Increased crop damage	• Overall height of the existing embankment should be raised up to 3-4 feet particularly from Haripur to Matnakandi to protect Boro crop from early flash flood. • Regular dredging of the rivers has to be ensured in order to reduce the intensity of flash flood. • Rehabilitation works should be finished by February • Quality materials should be used for rehabilitation works. • Short duration high yielding or hybrid varieties should be used instead of long duration BRRI dhan29 variety. • Local varieties should be transplanted in the deeper part of the haor area instead of short height high yielding or hybrid variety.	
Increased use of agro-chemicals	• Farmers should be encouraged to use organic manure to increase soil fertility while avoiding water contamination and reduce the soil fertility. • Farmers should be encouraged to cultivate leguminous crops to enhance the soil quality. • Farmer should be follow modern agricultural technology like Integrated Pest Management/Integrated Crop Management (IPM/ ICM), Good Agricultural Practices (GAP) etc.	
Loss of total fish habitat area by 61 ha (contributed by loss of beel and khal area)	• Re-excavation of silted up khal and seasonal beel • Maintenance work should be conducted as and when necessary for keeping water at a level in the Khal suitable for	

Impact	Mitigation Measures	Enhancement Measures
	fishery but not detrimental to agriculture crops; • Coordination among the line agencies should be increased and involve agencies in their respective functions. In this case, should involve Upazila Fisheries Office	
Slightly degraded habitat condition driving towards less sustainable provisioning services majorly fisheries.	• Water holding capacity in the Khals and in some cases in the Beels (i.e., Goniar Beel, Binner Beel, Hakkiaer Beel, Kosma Beel,etc.) should be increased through re-excavation/ dredging; • Maintain minimum 1 m water depth in almost all water bodies during dry season.	• Not applicable
Vulnerability to Beel resident fish species; and Possible inbreeding problem due to increase of culture exotic fish species.	• Unconventional fishing appliances (i.e., fine meshed gears, dewatering, poisoning, etc.) should be banned; • Should motivate and encourage agriculture sector people for abstaining from use of chemical fertilizers and pesticides for keeping water uncontaminated.	• Beel nursery programme with native fish species should be increased; • Build more sanctuary with the involvement of adjacent fishers community; • The protected area should be guarded especially at night by the professional fishers of adjacent village for facilitating fish species diversity and fish propagation.
There is significant implication of interventions on fish migration particularly for SIS.	• Increase the conveyance capacity of Khal maintaining minimum 1m depth during dry season; • Fish friendly structures should be implemented for suitable fish passage. • Fishing should be controlled during pre-monsoon and recession period.	• Proper maintenance work should be conducted and monitored by the Project Implementation Committee (PIC). • Monitoring and awareness building activities should be conducted through fishers' communities under the guidance of Upazila Fisheries Officer.
Overall fish production gain is about 2,201 metric ton in 2015 compared to production of 1989.	• Beel fishery should be promoted with three-year rotation; • Beel dewatering should be stopped.	• Above measures.
Increased use of unconventional fishing appliances and thus increased fishing pressure.	• Unconventional fishing appliances should be stopped; • Should increase law enforcement for controlling unlawful fishing. • Strong surveillance for maintaining water control structures through controlling fishing.	• Not applicable
Fishing based livelihood of commercial fishers becomes unsustainable due to dominancy of part-time fishers.	• Fishing ban time income generating activities should be promoted. In that case, the fisher's community should be involved in water management group.	• Not applicable
Beel fishery is being secured by the scheme	• The scheme should be	• Not applicable.

Impact	Mitigation Measures	Enhancement Measures
though the weak enforcement is not yielding expected benefit.	maintained with the coordination of the line agencies.	
Pitali, Hijol, Koroch and Nolkhagra have been decreased due to agricultural and human settlement expansion	• Keeping the *kanda*s and village grooves untouched in Govt. *khash* land. • Initiating plantation programme along the river levees, *kanda*s and other khash lands	
Reduced population of Pallas's Fish Eagle, Vulture and Monocellate Cobra	• Increase people awareness about wildlife conservation • Govt. initiative is required to conserve respective amount of natural vegetation and reedland in the haor area	
Reduced Water Lilly, Makhna, and *Chhaila* Grass	• Control over harvesting of aquatic plant resources	
Indian Roofed Turtle, Ganges River Dolphin, and Eurasian Otter has disappeared; Reduced population of Monocellate Cobra and migratory birds	• Identify the core habitat for the endangered animals and take action to conserve the respective habitats • Aware local farmers for using optimum doses of fertilizers and insecticides	
Reduced biodiversity regarding the swamp forest and their vicinity Nolkhagra have been rare due to conversion of reedland	• All the khash land with swamp forest and reedlands should be out of public lease and allotments	
Employment opportunity has been created		• Training would be ensured for the creation of alternative livelihood options • Submergible embankment must be repair using the local labor • Allocation of all beel /JallMohal to the actual fishermen on equity basis • Soft loan would be provided especially in the emergency period (i.e. post flooding condition) • Build up linkage with farmer and national, international traders
(Labor and Seasonal Migration) The demand for labor would have to be increased. But here it is noted that after the period of project intervention, The net demand for agricultural labor (having with technological innovation) is near about 160 per ha whereas most of the labor come from the		• Skill development training program should be initiated for capacity building especially for women to make them capable to earn money at home. • Affordability through the soft loaning mechanism should be ensured to earn foreign currency sending the labor in foreign market • Provide loan services by low interest to promote young entrepreneurs as their alternative

Impact	Mitigation Measures	Enhancement Measures
local areas. The incoming rates of labor from other regions were being increased after the time of project intervention.		livelihood options.
(Agriculture and wage base income) Agricultural production base income was increased due the project intervention. Agricultural wage labor income increased during the period of after project condition.	-	• New variety in production with the changes of seasonality should be initiated • Innovative training programs should be initiated to cope up with the changing technology
(Land Price) The opportunities for agricultural production were increased in which the value of agricultural lands was being increased with the period of after project condition.		• Regular Maintenance and protection work should be implemented properly to keep the land arable • The siltation during the flash flood would be controlled through the development of regular monitoring system.
(Accessibility in Health and Educational institution) The communication system became easier after the time of project intervention. Due to lack of proper maintenance, the damage of the embankments was increased and local people started to face problem to use these embankments as their means of communication.	-	• A monitoring Committee should be formed in association with WDB and local people to identify damaged area. • A hot line (i.e. calling system) should be developed to get regular update, flooding condition and damage information during the emergency • Design of operation and maintenance (i.e. Submergible embankment) would be ensured through the participation of local stakeholders
(Institution and Governance) • There is no mechanism to understand local people's concern in terms of project operation and maintenance. • The role of institution to consider public demand in policy, operation and maintenance on the issue of those submergible embankments. • The practice of good governance is unavailable that lead to increase damage of those embankments	• Quarterly Meeting should be initiated with local water and flood protection committee to understand the gap of institutional policy and governance • A Monitoring team should be formed to visit during the maintenance of those submergible embankments • People's feedback should be taken before the implementation of any kind of policy in relation to new project and maintenance and operation of those submergible embankments.	

Appendix: A

Table A-I: Availability of major fish species in Halir Haor (but not limited)

Sl. No.	Local Name	Scientific Name	IUCN Status, 2015
1	Ayre	*Sperataaor*	VU
2	Bacha	*Eutropiichthysvacha*	LC
3	Baghair	*Bagariusbagarius*	CR
4	Baila	*Glossogobiusgiurus*	LC
5	Bajari Tengra	*Mystustengara*	LC
6	Barobaim	*Mastacembalusarmatus*	EN
7	Boal	*Wallagoattu*	VU
8	Catla	*Catlacatla*	LC
9	Chapila	*Gudusiachapra*	VU
10	Chang	*Chana orientalis*	LC
11	Chital	*Chittala chittala*	EN
12	Darkina	*Esomusdandicus*	LC
13	Ghoinya	*Labeogonius*	NT
14	Gojar	*Channamarulius*	EN
15	Gutum	*Lepidocephalichthys guntea*	LC
16	Kabashitengra	*Mystuscabasius*	NT
17	Kachki	*Coricasoborna*	LC
18	Kaikla	*Xenentodoncancila*	LC
19	Kajuli	*Ailiacoila*	LC
20	Kalibaus	*Labeocalbasu*	LC
21	Kanipabda	*Ompokbimaculus*	EN
22	Kashkhaira	*Chela laubuca*	LC
23	Katari Chela	*Salmostomabacaila*	LC
24	Kholisa	*Colisafasciatus*	-
25	Koi	*Anabas testudineus*	LC
26	Kuchia	*Monopteruscuchia*	VU
27	LalChanda	*Chanda ranga*	-
28	Lalkholisa	*Colisalalius*	-
29	Magur	*Clariasbatrachus*	LC
30	Mrigal	*Cirrhinusmrigala*	NT
31	Mola	*Amblyphayngodon mola*	LC
32	Nandil, Nandi, Nandina	*Labeonandina*	CR
32	Napit koi	*Badisbadis*	NT
33	Potka	*Tetradoncutcutia*	LC
34	Rani	*Botia dario*	EN
35	Rita	*Rita rita*	EN
36	Rui	*Labeorohita*	LC
37	Shilong	*Silonia silondia*	LC
38	Shing	*Heteropneus fossilies*	LC
39	Shol	*Channastriatus*	LC
40	Tara baim	*Macrognathusaculatus*	NT
41	Tengra	*Mystusvittatus*	LC
42	Tit puti	*Puntiusticto*	LC
43	Veda/ Mani	*Nandusnandus*	NT
	Etc.		

Appendix B: Photo Album

Water Resources

Agriculture Resources

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Humaipur Haor Project

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1. Introduction

1.1 General Information

Humaipur Haor Project is located in between north latitude 24°18'49.08" and 24°12'42.92" and between 90°58'11.66" and 91° 3'59.18" east longitude. It falls under three Upazila viz.Bajitpur, Nikli and Austagram under Kishoreganj District.Two major rivers flow around the haor. The Ghora Utra River flows along the east side of the haor and Dhaleshwari beside the west side of the haor. These two rivers are the main sources of water in the haor area. Besides, there are a few numbers of beels, namely; Mankhola Beel, Barun Beel and Banul Beel inside the haor.

1.2 Project Descriptions

Humaipur Haor Project is a Flood Control Drainage and Irrigation (FCDI) project. The key objective of the project was to protect the haor area from flash flood to ensure the cultivation of Boro Rice. It was initiated in the year 1957 and completed in 1986. The water management infrastructures of the Humaipur Haor Project include the following:

- Submergible Embankment: 58 km.
- Regulator: 5 Nos.
- Pipe sluice: 3 Nos.

1.3 Present Status of the Project Interventions

The Humaipur Haor Project was initiated in the 50s decade of the last century. After that no major repair work was done to the embankment of this project. As a result, the embankment has eroded a lot throughout the project area. This decayed embankment cannot withstand the pressure of the water and is getting damaged more every year.

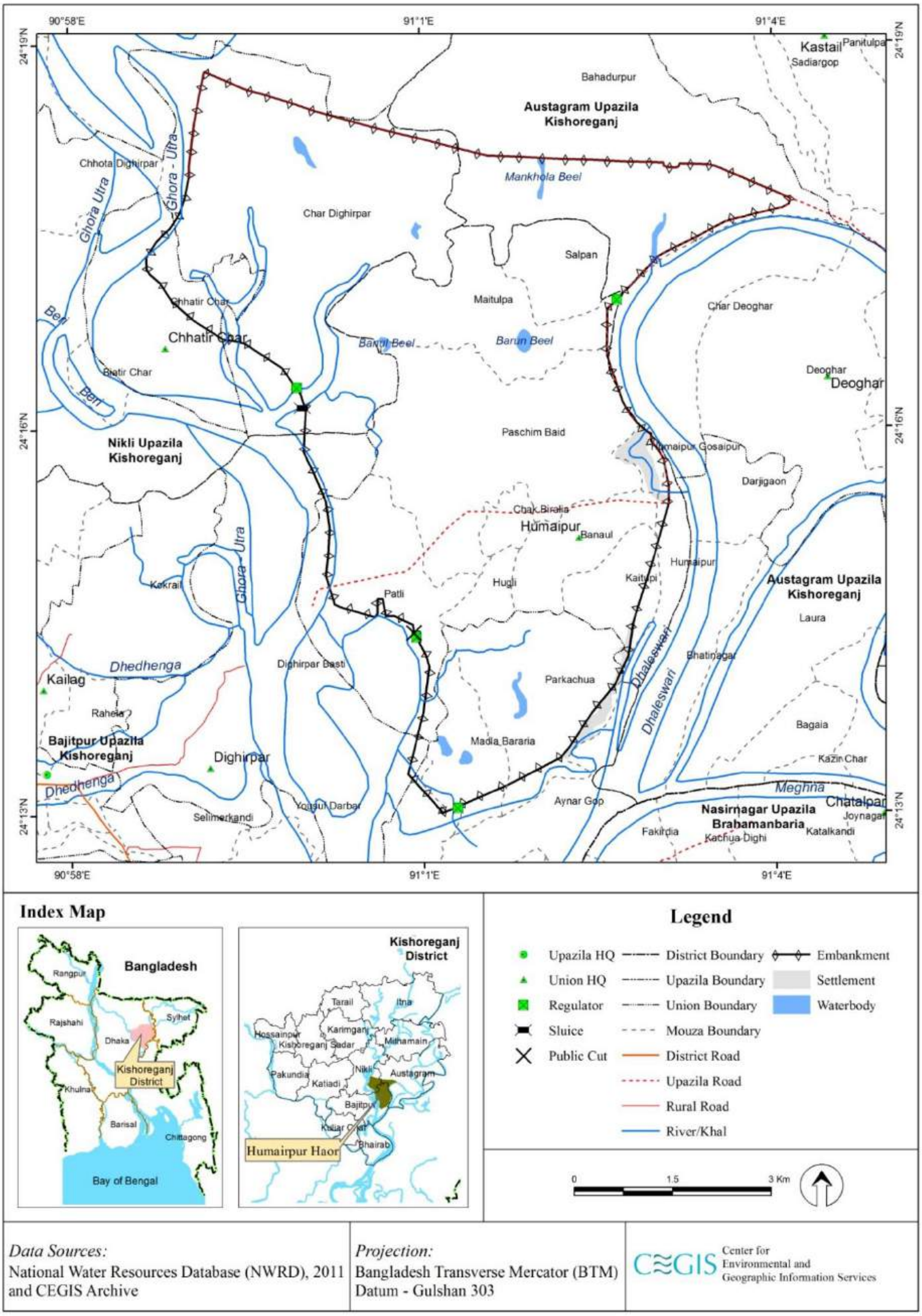

Figure 1.1: Hydrological Features of Humaipur Haor System

2. Water Resources

2.1 Flooding

Pre Project

Humaipur Haor area severely suffered from both flash flood and monsoon flood before the interventions. Almost all the low land in Humaipur village got inundated by about 15-18 feet of water during the monsoon.

Post Project

The agricultural land in the project area has been protected from flash flood after construction of the embankment. The embankment became submerged in the monsoon and inundated all the haor area. The people in the haor area received benefits for about 40 years since the construction of the embankment. However, the embankment has started losing its section since 90s due to wave action making it difficult to encounter flash flood. The submersible embankment has been eroded in many places. Even at some places, there is no sign of embankment. The flash flood arrives in April which is pretty earlier than monsoon floods. The flood water stays in the haor for about 8 months in a year In the event of depression at Bay of Bengal.

Impact

The project has saved the haor area from flash flood and the people living in Humaipur have enjoyed the benefits of this project for about 4 decades. However, in recent time, the embankment has been damaged at many places and people are suffering from flooding problem due to the lack of maintenance of the embankment.

2.2 Drainage and Sedimentation

Pre Project

Humaipur haor hardly faced any drainage and sedimentation problems before the project.

Post Project

Drainage and Sedimentation are still not problems in the haor area after the project. Since the haor continuously receives flow from two big rivers Ghora Utra and Dhaleshwari, sediment cannot get deposited on the bed of the river and haor. It washes away with the continuous flow of water. For this reason, even after 60 years of the project, the Humaipur haor area hardly faces problems regarding sediment and drainage.

Impact

The implementation of Humaipur Haor project has not impacted the drainage and sediment condition of the haor area.

2.3 Erosion

Pre Project

There was erosion in Humaipur haor system before the project, but was not very threatening. The northern part of the haor faced most of the erosion problem at that time.

Post Project

Erosion has become a severe problem in Humaipur Haor after the project. In the last 30 years, 200-250 acres of land has been eroded in Patli and Madla Baria area, situated in the south-west part of the project. The Shahpur village having an area of almost 450 acres has been devoured by the Ghora Utra River. This has been happening all around the haor area. However, the cause of such erosion cannot be firmly attributed to the project interventions.

Impact

Erosion has increased a lot in Humaipur haor area after the project in recent time.

2.4 Navigation

Pre Project

The people living in the haor area used water vessels as a dependable mode of communication prior to the project. But only 2 or 3 water vessels departed from Humaipur for long distance travel every day.

Post Project

The navigational connectivity between the haor and the peripheral rivers does not persist in pre-monsoon period due to submersible embankment. People make public cut inside the embankment in the pre-monsoon to have access to the peripheral river from the haor. In the post-monsoon period, there is no problem of navigation in the haor. Humaipur haor is on the east side of Ghora Utra River which is a key route of Bhairab-Azmiriganj route. Inside the haor, both motorized and non-motorized water vessels ply. The non-motorized boats are used to travel to adjacent villages and for fishing mostly. But there are lot of big motorized boats which carry both goods and passengers to different places, particularly Azmiriganj, Bhairab etc. It was also seen during the field visit that, a launch was carrying passenger from Humaipur to Bhairab. Even a dock-yard has been built on the opposite side of the haor to support navigation.

Impact

The navigational communication has tremendously increased compared to the pre-project period. The people of Humaipur presently rely on water vessels more to go to important places of Kishoreganj and other districts.

3. Land Resources

The project area has fallen in one Agro-ecological zone, namely: Old Meghna Estuarine Floodplain (AEZ-19). Non-calcareous dark grey floodplain soil is the dominant soil. The top soil texture are clay and loam; where loam texture is dominant. The soils are moderately permeable and have a moderate or low moisture holding capacity. The land type characteristics are not uniform within the project area. About 87% of cultivable areas are low to very low land where minimum flooding depth is above 1.8 meter during the monsoon period. The recession of surface water from agriculture land starts at first week of October and become free of flood water in middle of December.

Two indicators (Land use and Sand carpeting area) have been selected for assessing the impact on land resources due to structural interventions in Haor ecosystem. The land use and sand carpeting information under pre-project and existing situations were identified through analysis of the available archived satellite images of CEGIS and it was verified through Focus Group Discussion (FGD) and Key Informant Interview (KII).

Though the project has been completed during 1986, assessment of land use change has been performed on the basis of available LandSAT image of 1989 and 2015 keeping in consideration that land use of 1989 represents the equivalent land use of earlier of project implementation.

3.1 Land Use

Pre Project

The project boundary has been considered as similar to post project. The gross area of the project was 5,224 ha, of which Net Cultivated Area (NCA) was 5,063 ha. The rest area was covered with water bodies (baor, beels, river and khals) and settlements including homestead vegetation. Details are presented in Table 3.1.

Post Project

The gross area remaining same and the Net Cultivated Area (NCA) is 5,039 ha. The rest area are covered with waterbodies (pond, baor, beels, river and khals), settlements including homestead vegetation and Others (Brickfield). Details are presented in Table 3.1.

Impact

Net cropped area has decreased about 24 hectare. On the other hand, waterbodies, settlement and others area have increased about 16, 7 and 1 hectare respectively. Detailed impacted area is presented in Table 3.1.

Table 3.1: Detailed Land Use in Humairpur Haor System

Land use	Pre-project Area (ha)	Post-project Area (ha)	Impact (Post-project-Pre-project)
Agriculture	5,063	5,039	-24
Waterbodies	131	147	16
Settlement	30	37	7
Others	-	1	1
Total	**5,224**	**5,224**	**0**

Sources: Satellite Image-Landsat OLI, 1989 and 2015

3.2 Land Degradation

No sand carpeting was found before or after implementation of the project.

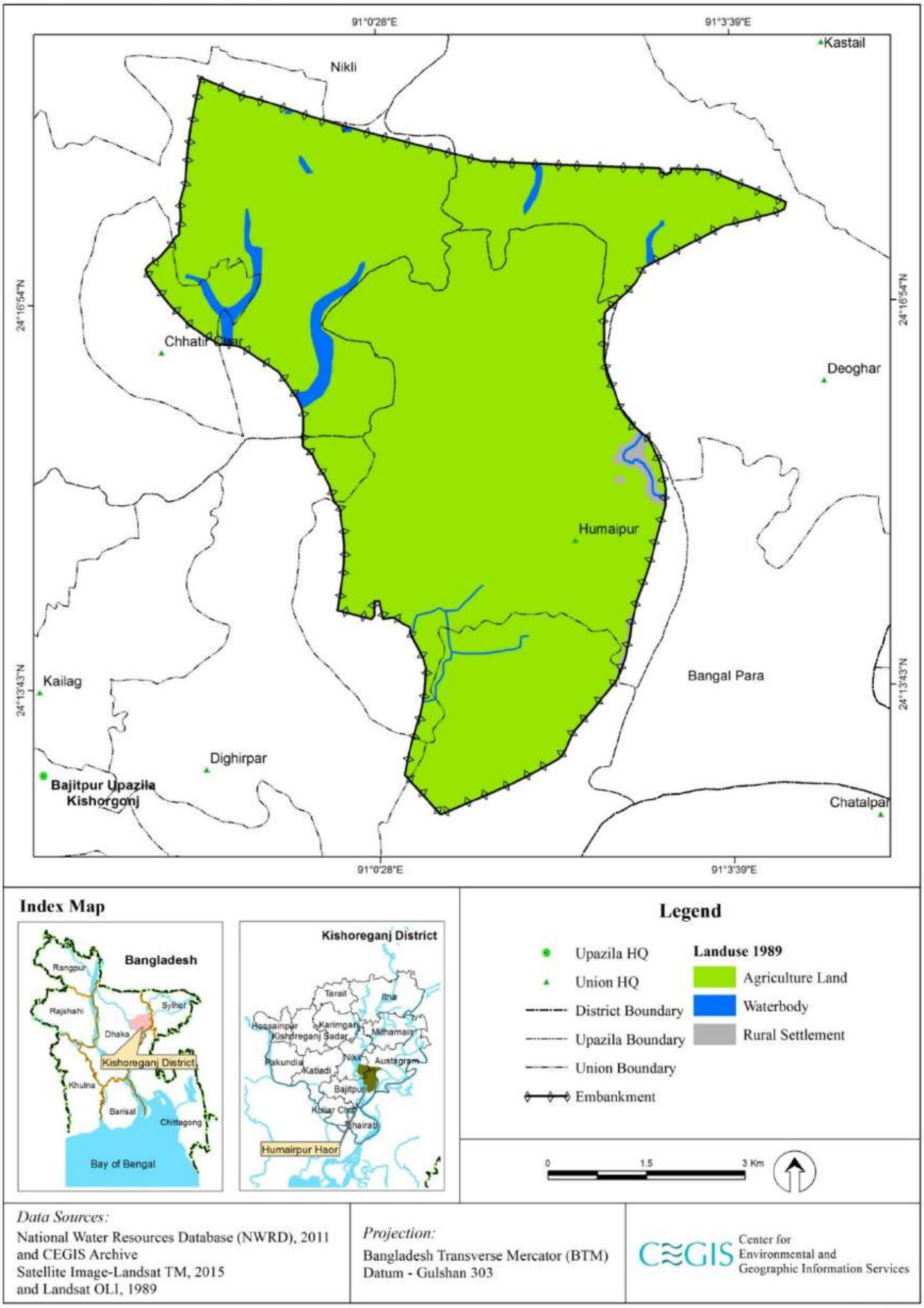

Figure 3.1: Land Use of Humaipur Haor Project (1989)

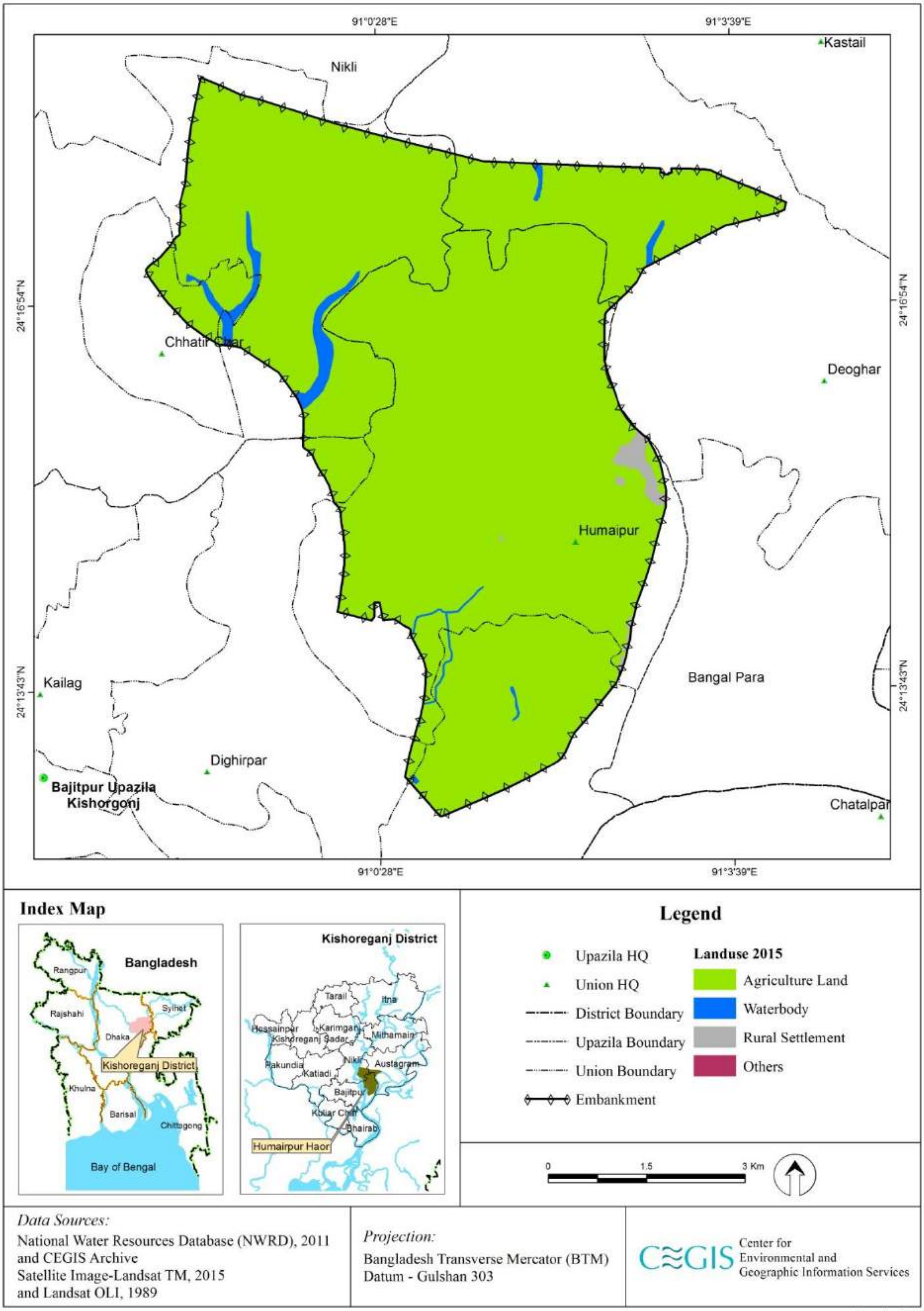

Figure 3.2: Land Use of Humaipur Haor Project (2015)

4. Agriculture Resources

Boro rice is the main crop in Haor areas. In most cases, pre-matured or matured Boro crops are damaged by early flash flood which generally happened due to pre-monsoon heavy rainfall in the hilly areas. Besides, drainage congestion and irrigation water scarcity due to siltation of rivers, khals and beels are the another problem for Haor agriculture.

Six indicators (cropping intensity, crop area, crop production, crop damage, irrigation and use of agro-chemicals) have been selected for assessing the impact on agriculture resources due to structural interventions in Haor ecosystem. The information of these indicators were collected from both primary and secondary sources. The primary data were gathered from stakeholders through Focus Group Discussion (FGD) and Key Informant Interview (KII). The secondary data were collected from Bangladesh Bureau of Statistics (BBS) and field level Department of Agricultural Extension (DAE) office.

4.1 Cropped Area, Cropping Pattern and Intensity

Pre Project

Before the project interventions, the Net Cropped Area (NCA) was 5,063 ha, where only one cropping pattern Fallow- Fallow- Local Boro was found. The land type of this project area was low land (about 62% of NCA) followed by very low and medium low land as presented in Table 4.1.

Farmers usually grew Local Boro rice in Rabi season. Different varieties of Boro rice such as Gochi, Boro, Tepi Boro, Laita shail, Rata and Shail were very much popular among the farmers. The total cultivable area was covered with single cropped area. So, the cropping intensity of this area was 100%. Detailed cropping pattern by land type under pre-project situation is presented in Table 4.1.

Table 4.1: Pre-project Cropping Pattern of the Humairpur Haor System

Land type	Kharif-I (March-June)	Kharif-II (July-October)	Rabi (November-February)	Area (ha)	% of NCA
Medium Low Land (F_2)	Fallow	Fallow	Local Boro	658	13
Low Land (F_3)	Fallow	Fallow	Local Boro	3,139	62
Very Low Land (F_4)	Fallow	Fallow	Local Boro	1,266	25
Total				**5,063**	**100**

Source: CEGIS estimation based on field information, November; 2017

Post Project

The project area became protected from early flash flood due to the interventions, which influenced farmers to grow HYV Boro crops instead of local Boro. HYV Boro crops also produces higher yield than local varieties. The most popular varieties which are used in the project area are BRRI dhan 28 and BRRI dhan 29. The Net Cultivable Area (NCA) has been decreased to 5,039 hectare after interventions. Dominant cropping pattern of the project area is Fallow - Fallow - HYV Boro covering 92% of the NCA. The total cultivable area is covered with single cropped area. So, the cropping intensity remained same, which is 100%. Detailed cropping pattern by land type under with project situation is presented in Table 4.2.

Table 4.2: Post-project Cropping Pattern of the Humairpur Haor System

Land type	Kharif-I (March-June)	Kharif-II (July-October)	Rabi (November-February)	Area (ha)	% of NCA
Medium Low Land(F_2)	Fallow	Fallow	HYV Boro	655	13
Low Land(F_3)	Fallow	Fallow	HYV Boro	3,124	62
Very Low Land(F_4)	Fallow	Fallow	HYV Boro	850	17
Very Low Land(F_4)	Fallow	Fallow	Local Boro	410	8
Total				**5,039**	**100**

Source: CEGIS estimation based on field information, November; 2017

Impact

The Net Cultivable Area (NCA) has been decreased to 24 hectare after the interventions. The cultivated area of Local Boro has gradually been decreased and replaced by HYV Boro variety after completion of project due to its higher yield rate and ensured early flash flood protection by project interventions. Impact on cropped area is presented in Table 4.3.

Table 4.3: Impact on Cropped Area in Humairpur Haor System

Crop name	Pre-project Area(ha)	Post-project Area(ha)	Impact (Post-project – Pre-project) Area(ha)
HYV Boro	-	4,629	4,629
Local Boro	5,063	410	-4,653
Total	**5,063**	**5,039**	**-24**

Source: CEGIS estimation based on field information, November; 2017

4.2 Crop Production

Pre Project

The estimated total annual crop production of the project area was about 10,987 tons after loss of 3,190 tons before any interventions. Detailed crop production statistics before interventions is presented in Table 4.4.

Table 4.4: Annual Crop Production in Humairpur Haor System under Pre-project Situation

Crop name	Total crop area(ha)	Damage free area		Damaged area		Annual production (ton)	Production lost (ton)
		Area(ha)	Yield (ton/ha)	Area(ha)	Yield (ton/ha)		
Local Boro	5,063	3,291	2.8	1,772	1.0	10,987	3,190
Total	**5,063**	**3,291**	**-**	**1,772**	**-**	**10,987**	**3,190**

Source: CEGIS estimation based on field information, November; 2017

Post Project

After the implementation of the project, hydrological regime of the project area is changed. Farmers started to cultivate HYV Boro due to presence of submersible embankment, compartmental embankment, regulator and closure, which protect their crops from early flash flood. Hence, total annual crop production is about 20,373 tons with loss of 4,846 tons after interventions. Detailed estimation of crop production after interventions is presented in Table 4.5.

Table 4.5: Annual Crop Production in Humairpur Haor System under Post-project Situation

Crop name	Total crop area (ha)	Damage free area		Damaged area		Annual production (ton)	Production lost(ton)
		Area(ha)	Yield (ton/ha)	Area(ha)	Yield (ton/ha)		
HYV Boro	4,629	3,379	5.2	1,250	1.5	19,446	4,624
Local Boro	410	287	2.8	123	1.0	927	221
Total	**5,039**	**3,666**	**-**	**1,373**	**-**	**20,373**	**4,846**

Source: CEGIS estimation based on field information, November; 2017

Impact

Additional 9,386 tons rice is being produced in post project situation. The rice production is increased due to the protection of flash flood which encourages the farmers for practicing high yielding variety instead of local variety. Detailed estimation of impact on crop production is presented in Table 4.6.

Table 4.6: Impact on Crop Production in Humairpur Haor System

Crop name	Pre-project Production(ton)	Post-project Production(ton)	Impact (Post-project - Pre-project)
HYV Boro	-	19,446	19,446
Local Boro	10,987	927	-10,060
Total	**10,987**	**20,373**	**9,386**

Source: CEGIS estimation based on field information, November; 2017

4.3 Crop Damage

Pre Project

Flash flood was the main cause of crop damage in pre-project situation. Before harvesting of Boro crop, water entered into the Haor area and damaged the crops. So, farmer of this area suffered due to the damaging of their crops in every year. Total crop damage in the project area was 3,190 tons annually. Detailed estimation of crop damage is presented in Table 4.4

Post Project

Humairpur Haor is now protected from early flash flood by the project interventions which basically performed well up to 2003. After that, most of the year, flood water enters into the project area before harvesting of Boro crop (early to mid-March) due to low height of submersible embankment and malfunctioning of structures at Chhatir char, Char Dighirpar, Parkachua, Patli, and Salpan Mouza.

Floodwater enters into the project area through the surrounding Ghra Utra River and Dhaleswari River either by overtopping or by breaching the embankment at several locations. The height of embankment of the Haor is low in comparison with the design level and more than 10 breaches are located in this embankment at Chhatir char, Char Dighirpar, Parkachua, Patli, and Salpan Mouza. Every year BWDB closes the major breaches and entrances of the khal. The main reason for flooding in this Haor over the years is that the rivers have silted up and their water flowing capacities are gradually reducing. The excessive sedimentation makes rivers incapable of holding and conveying floodwater, which creates excessive pressure on earthen embankment. Moreover, plant height of HYV is less than local varieties and growing period of most of the HYV varieties are higher than local varieties except BRRI dhan 28. So, flood water affects the whole crop area at a time. The devastating floods of 2004 inundated the project area on the mid-week of April. Local people reported, around 80% of Boro both HYV and local varieties were damaged by the devastated flood. In 2007, around 90% of Boro both HYV and local varieties were damaged by the devastated flood. But, this year (2017), around 100% of Boro crop areas are damaged at pre-mature stage. Most vulnerable locations: Chhatir char, Char Dighirpar, Parkachua, Patli, and Salpan are identified at submergible embankment. Total crop damage in the project area is about 4,846 tons annually. Detailed estimation of crop damage after interventions is presented in Table 4.5.

Impact

Though, the crop damage area has been decreased from 35% to 27% after interventions. However, the amount of crop damage has increased by 1,656 tons because the total production has increased significantly. The crop damage area is increasing day by day due to malfunctioning of the interventions and reduced water carrying as well as retention capacity of surrounding rivers, khals and beels. Detailed impact assessment on crop damage is presented in Table 4.7.

Table 4.7: Impact on Crop Damage in Humairpur Haor System

Crop name	Pre-project Production loss (ton)	Post-project Production loss (ton)	Impact (Post-project - Pre- project)
HYV Boro	-	4,624	4,624
Local Boro	3,190	221	-2,968
Total	**3,190**	**4,846**	**1,656**

Source: CEGIS estimation based on field information, November; 2017

4.4 Irrigation

Pre Project

Before initiation of the project, only surface water was used for irrigating Local Boro crops. The local people normally transplanted this crop immediately after the floodwater recedes and the land is under shallow inundation. Local farmer reported that they stored water with help of bundh/dyke management and irrigated their crop with the help of flooded water in the low lying part of the Haor. They also used traditional modes like Seuti, Don and Cone for irrigating their crop from surrounding rivers, Beels and Khals during dry season. Prior to the implementation of the project, irrigation water was more available than the requirement of crops.

Post Project

After implementation of the project, the irrigation water demand has been increased due to cultivation of high water demanding HYV Boro instead of Local Boro crop. On the other hand, the availability of surface water is being reduced due to siltation of surrounding rivers, khals and beels of the project area. Therefore, the scarcity of irrigation water has been observed from early February to end of March in most of the year. In this time, Ghra Utra River and Dhaleswari River are the main source of surface water irrigation. Mainly Low Lift Pumps (LLPs) is being used for lifting surface water instead of traditional mode. In addition, about 10% of crop area is being irrigated from groundwater by using Deep Tubewell (DTW).

Impact

There was deficit of irrigation water due to increase of water demand and decrease of water availability during dry season. The irrigation water demand has increased for cultivating high yielding crop variety. On the other hand, surface water irrigation availability has decreased due to siltation of rivers, khals and beels of the project area.

4.5 Agro-chemicals Use

Pre Project

Farmers of the project area cultivated only Local Boro in pre-project situation. They didn't apply agro-chemicals for crop cultivation. However, some farmers used inorganic fertilizer like mixed grass and rice straw in the crop field for the restoration of soil fertility.

Post Project

Generally more agro-chemicals are required for cultivating HYV Boro crops. So, farmers applied more agro-chemicals for HYV Boro crop cultivation. Total about 1,557 tons chemical fertilizers, 7.0 Kilolitre liquid and 11 tons granular/powder pesticides were used in the study area for crop cultivation per year. Detailed use of agro-chemicals under post-project situation is presented in Table 5.8.

Table 4.8: Use of Agro-chemicals in Humairpur Haor System under Post-project Situation

Crop name	Fertilizer (Kg/ha)				Total (kg/ ha)	Pesticides	
	Urea	TSP	MP	Others		Liq. (ml/ha)	Gran. (Kg/ha)
HYV Boro	160	80	70	10	320	1500	2.2
Local Boro	100	40	40	5	185	800	1

Source: CEGIS estimation based on field information, November; 2017

Impact

Use of agro-chemical has increased largely under post-project situation compared to pre-project situation. Additional about 1,557 tons chemical fertilizers, 7.0 Kilolitre liquid and 11 tons granular/powder pesticides are used for crop cultivation annually. Detailed impact on use of agro-chemical is presented in Table 4.9.

Table 4.9: Impact on Agro-chemicals in Humairpur Haor System

Crop name	Pre-project			Post- project			Impact		
	Total Fertilizer (ton))	Pesticides		Total Fertilizer (ton)	Pesticides		Total Fertilizer (kg/ha)	Pesticides	
		Liquid (Kilo Litre/ha)	Powder/ Granular (ton)		Liquid (Kilo Litre/ha)	Powder/ Granular (ton)		Liquid (Kilo Litre/ha)	Powder/ Granular (ton)
HYV Boro	0	0	0	1481	6.9	10.2	1481	6.9	10.2
Local Boro	0	0	0	76	0.3	0.4	76	0.3	0.4
Total	-	-	-	1557	7.3	10.6	1557	7.3	10.6

Source: CEGIS estimation based on field information, November; 2017

5. Livestock Resources

Livestock and poultry, being an essential element of integrated farming system, play an important role in the economy of the Haor area. Livestock provides significant draft power for cultivation, threshing and crushing of oil seeds; cow dung as a source of manure and fuel; a ready source of funds; and meat, milk and eggs for human consumption. A large number of livestock are reared in Haor areas but constrained by flash flood causing inundation of large areas during most of the time in the year. This area is famous for duck rearing due to availability of natural feed for ducks in natural large water bodies. All of livestock species suffer much due to shortage of feed, outbreak of waterborne diseases and inadequate shelter facilities. The livestock rearer in the Haor areas do not get fair price due to poor communication as well as lack of marketing facilities.

The indicator status of livestock has been selected for assessing the impact of the project. The status of livestock population data were collected from Livestock Census (1986), Agriculture census (1996 and 2008) of BBS. The status of livestock feed and fodder, diseases, marketing facilities information were gathered from stakeholders through Focus Group Discussion (FGD) and Key Informant Interview (KII).

5.1 Status of Livestock Population, Feed and Diseases

Pre Project

According to livestock census 1996, the livestock and poultry population in the project area were 6,870 cattle, 2,480 goats, 37,760 chicken and 13,860 ducks (Table 5.1). Before implementation of the project, the major feed available to ruminants was mostly crop residues (rice straw) supplemented with weeds from cultivated fields. They are to depend on naturally grown grasses in Kandas and alongside roads and embankments. Most of the year before implementation of the project, the crops were to damage by early flash flood. As a result, shortage of feed from crop residues, reduction of grazing facilities seriously affect livestock rearing. That time, the small holders were to depend on water hyacinth and other aquatic plant for their cattle. The major poultry feeds were rice bran, broken rice, kitchen wastes like rice, rice-gruel, vegetables, fish wastes etc. In addition, the duck usually scavenge in the nearby waterbodies like Haor, beel, khal, river or any other low lying areas; mainly eat various types of aquatic insects, small fish, shell or snails. Major livestock and poultry diseases were Gola Fula (Haemorragic Septicemia), Foot and Mouth Diseases (FMD), Pox and Cholera, Duck Cholera, Fowl Pox and Fowl Cholera etc. The most vulnerable period was between July to November for spreading diseases to livestock and poultry populations. Mortality rate of the livestock/poultry was higher due to poor shelter condition and they lived in unhygienic condition. Marketing facilities was not in good condition and price was also low due to less demand of their products and by products. Producer consumed their products at family level and additional products were sold at local village market.

Table 5.1: Status of Livestock/Poultry in Humairpur Haor System

Livestock/ Poultry Category	Pre-project		Post-project		Impact
	No of Households having Livetock	Total No of Livestock	No of Households having Livetock	Total No of Livestock	Number of Livestock Population
Cattle	2,580	6,870	3,570	8,670	1,800
Goat	1,200	2,480	1,750	1,860	-620
Chicken	5,560	37,760	5,730	34,070	-3,690
Duck	2,460	13,860	2,020	11,620	-2,240

Source: CEGIS estimation based on livestock census (1996), agriculture census (2008) and field information (July 2017)

Post Project

According to agriculture census 2008, the livestock and poultry population in the project area are 8,670 cattle, 1,860 goats, 34,070 chicken and 11,620 ducks (Table 5.1). After implementation of the project, crop is protected from early flash flood. As a result, the feed availability of livestock is increased due to increase of crop production. However, some of the year, the crops were damaged by early flash flood. In that year, the small holders were dependant on water hyacinth and other aquatic plant for their cattle. The poultry feeds are same as in pre project situation. On the other hand, more or less similar diseases are found in post project situation. The mortality rate of the livestock/poultry became negligible during the project period, due to extension works at farmers' level such as immunization and insemination program by Department of Livestock (DLS). Marketing facilities during dry season also improved due to improvement of the communication system by constructing the submersible embankments. Therefore, market prices are increased due to high demand of products and by products.

Impact

From 1996 to 2008, about 1,800 cattle have increased due to the reduction of flood vulnerability, improvement of marketing facilities and strengthening of livestock extension services. On the other hand, the goat, chicken and duck population has been decreased to 620, 3,690 and 2,240 respectively. Details about impact on livestock are presented in Table 5.1.

6. Fisheries Resources

Fisheries resources are good and diversified in Humaipur Haor area. Numbers of perennial and seasonal beels, floodplain, khals and some fish ponds are present in the haor area. The haor is bounded by Ghora Utra River in north–west and Dhaleswari and Meghna in the south-west. The rivers are the main source of surface water of the haor area. Monsoon flood is a regular phenomenon. This is not flash flooded area. But, all the water goes to Meghna River through Humaipur haor area. So the water of early flash flood destroys the boro crop.

In the other hand, the rain water is coming directly to the haor or through different khals. The river and khals act as fish migratory route as well as sheltering place. In monsoon the floodplains are use as fish spawning and grazing area. The beels in the haor are enrich and diversified and contribute much in respect of fisheries production. Floodplain habitat that creates a good opportunity for fishing for several types of fishers in monsoon and post monsoon. And in boro season the floodplain is used as crop field except the perennial water area. Some fish ponds are present and contributing in fish production is insignificant.

The field team visited the haor area and observed the field scenario. The team discussed with the local farmers, fishers, local elites, businessman in some spots. They informed that the flash flood occurs due to upstream rain and enter the water into the haor area within few days. Water entering system in the Haor is almost same in pre and post intervention period. The submersible embankment is not in good condition. Fishing in the haor area is almost open for everybody.

6.1 Fish Habitat Area

Pre Project

The fish habitat namely river and khals in the haor area that play a vital role in respect of fish production. The adjacent river in the Haor areas is perennial in nature. The major beels are Mister beel, Dighar beel, Bikri beel, Borun beel, Kalajogar beel, Biralla Beel, Baoun Pushkuni beel, Banapol beel and Dobir beel. The main khals in the haor area are Humaipur Khal, Boruner Khal, Baro Khal, Koyra Khal, Pundhir Khal, Parkochua Khal and Madla Boruria Khal. The khals are of different shapes and lengths and the beels are connected with the river through these khals. The khals and beels are both seasonal and perennial in nature but they are mostly used as agriculture land in dry season. Water source of khals and beels are mainly Ghorautra River, Dhaleswari River and Meghna River. The floodplain in the Haor are inundated in monsoon and the water stay about 4 to 5 months per year. The floodplain area are basically used as breeding and feeding ground for the haor fishes in monsoon. Boro is the main crop in the project area. Most of the floodplain areas are used as crop field especially in dry season.

Fish habitat in the haor was 5161 ha. Out of that capture fish habitat was 5156 ha and fish pond 5 ha. Overall fish habitat scenario was comparatively good. And the connectivity of khals with beel, floodplain and river was smooth. Some khas land was present and most of them were water body.

Post Project

The rivers and perennial beels are silted up by silt through flash flood. The total fish habitat is 5169 ha. Of which 5167 ha capture fish habitat and 2 ha culture fish habitat. Capture fish habitat is increasing due to erosion of Ghora Utra River under Dighirpar Union. Photo of fish habitat in Humaipur haor area are given below in Figure 6.1.

Floodplain in the Humaipur Haor area

Floodplain Beel in the haor area

Figure 6.1: Fish Habitat of Humaipur Haor Area

Impacts

Increase the fish habitat 8 ha in post project period. Breakdown of fish habitat is given in the following Table 6.1.

Table 6.1 Fish Habitat of Humaipur Haor

Sl.	Fishery Category	Habitat type	Area (Ha)		Impact (Area Change in Ha)
			Pre project	Post project	
1	Capture	Perennial Beels	43	43	0
		River, Khals	74	94	+20
		Floodplain	5030	5023	-7
		Baor	9	7	-2
		Sub Total	***5156***	***5167***	***+11***
2	Culture	Culture pond	5	2	-3
		Sub Total	**5**	**2**	***-3***
		Grand Total	***5161***	***5169***	***+8***

Source – Based on Sate light Image 2015 and field findings

6.2 Habitat Condition

Fish habitat condition is excellent and very productive. But water bodies are changing because of siltation, river erosion and incremental boro cultivation in the haor area.

Pre Project

Habitat condition of fish and water quality was very good and very productive. The farmers mostly cultivate local variety of rice in pre haor condition. So use of agrochemicals and pesticides and fertilizer was of limited quantity.

Post Project

Boro cultivation is increasing in the haor area day by day. So use of agrochemicals, pesticides and fertilizer are increasing because of more cultivation of boro crop. The residues of those agrochemicals are going to the water bodies and reducing the water quality as well as habitat condition. Except these, the water and fish habitat in the haor area are also polluted by different types of wastages from homestead, market which is decreasing the habitat and water quality. Siltation is decreasing the water depth in beels area in post monsoon and also disrupting the sheltering place in the haor area in dry season.

Impacts

Depth of water in beels is decreasing in post monsoon period which is decreasing the sheltering place of fishes. The fish habitat and water quality are also degrading for wastage from brick field and incremental use of agrochemicals, pesticides and fertilizer in boro field.

6.3 Fish Diversity

Pre Project

During field visit it is reported by the local people and fishers that abundance of the species was very rich and diversified. Available fishes was mani, koi, puti, rui, catla, kalibaus, tengra, boal, kholisha, deshi sarputi, Ilish, magur, shing, pangus, kakila, chanda, taki, chang/okol, shol, potca, guchi baim, tara baim, mola, chela, gutum, baila, pabda, tit puti, foli, darkina, chapila, chital, ayer, bagha ayre etc. About 110 fish species were present in Humaipur Haor area.

Post Project

The numbers of fish species are almost same as before. But richness of fish species has some changes. Some species abundance like mani, pabda, ghonia, deshi sarputi, foli etc. They are increasing day by day which were almost unavailable few years ago.

Figure 6.2: Available Fish Species in Humaipur Haor Area

Some initiatives were taken by the Fisheries department to improve the resources. Photo of fish species in the haor area are given in the following Figure 6.2.

Impact

Increased the abundance of some fish species like deshi sarputi, mani, pabda, kalibaus, ghonia, boal, mola etc. because some initiatives have been taken by the Department of Fisheries (DoF).

6.4 Fish Migration

Pre Project

In pre project condition fish migration and movement were smooth. Most of the fish species used the shallow depth for breeding and feeding purpose and migrated without any obstacle. Fish migration and movement was smooth.

Post Project

Migration are hampering due to construction of embankment, regulators. Beside this siltation in river, khal and beel bed also disturbing of the fish migration and there are also some man made obstacles. So the spawning and feeding grounds are reducing day by day in the haor area

Impact

Delaying of fish breeding of small fishes and disruption of fish migration due to decreasing of spawning and feeding grounds.

6.5 Fish Production

Pre Project

Fish production per year 1057 Metric Ton (MT). From capture habitat was about 1053 MT and from culture habitat was about 4 MT per year.

Post Project

Per year fish production is now 1325 MT. From capture habitat it is 1323 MT and culture habitat is about *2* MT.

Impact

Fish production increased about 268 MT per year. The location of this haor is adjacent to three rivers namely Ghora Utra, Dhaleswari and Meghna River. The incremental fish production may is due to location of haor, increasing of fishing activities and commercialization of fishing etc. Fish productions from pre project and post project scenario are given in the following Table 6.2.

Table 6.2: Breakdown of Fish Production by Habitat Type of Humaipur Haor

Sl.	Fishery Category	Habitat type	Production (MT)		Impact (Production Change in MT)
			Pre project	Post project	
1	Capture	Perennial Beels	26	39	+13
		River and Khal	15	24	+9
		Floodplain	1006	1256	+250
		Baor	6	4	-2

Sl.	Fishery Category	Habitat type	Production (MT)		Impact (Production Change in MT)
			Pre project	Post project	
		Sub Total	***1053***	***1323***	***270***
2	Culture	Culture habitat	4	2	-2
		Sub Total	***4***	***2***	***-2***
		Grand Total	**1057**	**1325**	**+268**

Source: Fish production assessment based on field findings and FRSS data 1989 and 2015.

6.6 Fishing Appliance

Pre Project

Mesh size of net was above 2-3 cm (about 1 inch) that was mostly used to catch the fishes in pre project situation. Types of used gears for fishing like koi jal/puti jal, ber jal, khora jal, thela jal, jhaki jal, borshi, , Gui (made by bamboo that used to catch small fishes) was used to catch fishes from the Humaipur Haor area. That gears was fish friendly and protected the small fishes during fishing because of big mesh size. Lease system was present.

Post Project

The gear which was used as earlier are all most same. At present Fishers are using nets and traps like moshari jal (small mesh size net below 0.1 cm) which is damaging the fish fry as well as habitat quality. They are using Kironmala (one type of trap made by plastic sheet and use fish feed inside the trap) a new trap to catch gura icha which is not fish friendly. In some cases the part time fishers are catching fish from the beel by dewatering in post monsoon period.

Impact

New nets like moshari jal (small mesh size net) and *kironmala (trap)* are using which are not fish friendly and damaging the fish fry as well as habitat quality.

6.7 Fishers Livelihood

Different types, like permanent, part time and subsistence fishers are involved with fishing activities in Humaipur Haor area. Both Hindu and Muslim fishers are present. The professional fishers used to catch fish in the haor area during monsoon and post monsoon period about 5 to 6 month per year. After that they are catching fish in adjacent river.

The professional fishers are fully dependent on fishing for their livelihood round the year. But the part time fishers catch fish about 3-4 months after inundation of haor area. After fishing, the part time fishers are engage with agriculture activities. The subsistence fishers catch fish for own consumption.

Pre Project

The professional fishers was involve to catch fish in the haor area about (5-6) month per year. After that they catch fish in Ghora Utra, Dhaleswari and the Meghna River and fish culture pond in the area. Most of the professional fishers were Hindu. The number was limited in pre project period and the Muslim professional fishers were almost absent.

Post Project

Good numbers of fishers are involved with fishing in monsoon and post monsoon period. Basically the numbers of fishers are increasing day by day. Especially the numbers of part time fishers' are increasing rapidly. The part time fishers are mostly from Muslim community. Beside, some people are involved as fish aratder, ice producer, retailer, fish labor, transport worker etc. for their livelihood.

Impact

Fishing pressure is increasing due to increasing of the fishers' number. That creates a problem especially, for the professional fishers and decreases the earning. Beside this, good number of people are involving as fish retailer, fish aratder, ice producer, fish labor, transport worker etc. for their livelihood. Overall the number is increasing day by day.

6.8 Fisheries Management

Pre Project

No restriction in fishing of pre project situation. Monsoon and post monsoon period werethe peak time for fishing in the haor area. And the fishing was almost smooth. Even some water areas were untouched in beel or adjacent river as safeguard for the broodfish. That helps for next year breeding. Fish catch by dewatering in beels was almost absent.

Post Project

No restriction of fish catch in haor area. But restricted in post monsoon period especially in private own beels, katha / jhata (brush pill) and adjacent areas. Fish catch by dewatering in beels are happing in some extent.

Impact

Fishing by dewatering decreased the fish habitat quality. That influence negatively for next year fisheries resources.

7. Ecosystem

The Humaipur Haor roughly consists of 5224 hector area. The project area is spread in-between 3 upazilas of Kishoreganj district. The south-western part is inside Bajitpur upazila, western and north-western part belongs to Nikli upazila, northern and north-eastern part belongs to Austogram upazila. The embankment of Humaipur haor instigated in 1956 and concluded on 1986. In these 30 year period lots of environmental changes took place in the project area. The embankment is almost ruined in various places due to river erosion. The project area possesses a unique ecosystem that supports various types of terrestrial and aquatic floral and faunal species. Terrestrial ecosystem belongs to different homesteads, *kanda* etc. The remaining flora is aquatic life-forms which are spread throughout the haor area, beels, connecting khals and the river surrounding the project area. The major beels in the project area are Dighail, Borokachua, Chotokochua and Madlar beel etc. The haor basin indicator flora and fauna were less present at this part of the project.

7.1 Terrestrial Flora

Terrestrial floras are the floral group that is found only on landforms. The study area comprises of different terrestrial species but most commonly found in some specific areas. Hijol, Koroch are found in Humaipur haor. In homestead area the fruit yielding tree species as well as timber tree are commonly found. Mango and jackfruit tree was most popular fruit yielding tree among others and Mehogoni, Chambul tree are most favourite among the locals as timber tree. The bushy shrubs like Dholkolmi, different herbs and grasses were commonly found over the area.

Pre Project

Major terrestrial flora of this haor took place on settlement platforms, canals and riverbanks and at crop fields. Before intervention started in 1957, the study area was comprised of different terrestrial species but dominant tree species were naturally grown Hijol and Koroch trees. The previous vegetation coverage area was much higher in the past. Cultivation of paddy was less due to unavailability of dry land.

Post Project

According to aged persons living in the area, the present vegetation coverage area is less than the past (before intervention) for increasing population. Homestead vegetation gradually increasing with timber trees. Mehogoni, Acacia, Chambol tree etc has been identified as common timber yielding tree in the project area. Hijol, Koroch are less common as the population growth and the protection wall built by government around homestead area. And after the intervention cultivation of paddy has been increased.

A. Humaipur Haor area

B. Koroch tree beside homestead area

C. Dholkolmi plant near Parkochua village

Figure 7.1: Natural Vegetation at Homestead and Other Areas of Humaipur Haor

Source: CEGIS field visit 3rd& 4th November, 2017

Impact

The interventions like the embankment, sluice gate/regulator establishment, protection wall may be paving the way to enhance the diversity of flora. But the river erosion and disruption of the embankment has been playing a major role in the depressing of floral diversity, population density and their daily needs are also downing the current status. Access to more people to harvest natural resources as per demands has been leading depletion of terrestrial floral coverage due to overexploitation. Therefore, the ultimate goal of the interventions was dismay. The specific impact on flora has been depicted below in Table 7.1.

Table 7.1: Changes of Status of Indicator Species

Indicator Species	Pre Project	Post Project	Cause of status change
Pitali/Mera	Common	Rare	Less demanding and planting of timber trees instead of water resistant flora.
Hijol	Abundant	Less	overharvesting
Koroch	Abundant	Less	Overharvesting, Less demanding and planting of timber trees instead of water

Indicator Species	Pre Project	Post Project	Cause of status change
			resistant flora.
Barun	Less	Less	Less demanding and planting of timber trees instead of water resistant flora.
DholKolmi	Common	Medium	overharvesting
NolKhagra	Less	Rare	N/A

7.2 Terrestrial Fauna

Pre Project

Terrestrial vegetation was the shelter and roosted place for different bird species especially Pallas's Fish Eagle, Brahminy Kite, Vulture and other common birds. Huamipur haor area was not favorable place for medium sized mammals like fishing cat, jackal and other wildlife. According to local elderly people, otter was very commonly seen inside the project area. The reptiles and amphibians population was also found good in number.

Post Project

Throughout the post-intervention period, the terrestrial faunal status had been declining for some species and some species are increasing. Most of the dominant terrestrial fauna turned into lessened category due to different anthropogenic activities. After implementation of interventions, it had paved the way to produce more crops instead of keeping lands unproductive. As a consequence, terrestrial fauna lost their suitable habitats where they build nests, groom for breeding and take parental care to their offspring. But commonly available terrestrial birds like Black Drongo, Common Myna, Asian Pied Starling, Oriental Magpie Robin, Spotted Dove, House Sparrow, Common Tailorbird, etc. has been sighted good in number and their population remains almost similar in comparing pre-intervention period. Among the reptiles, the Common Garden Lizard, House Lizard, Skink, are reported to be commonly found in the area. Indian Rat Snake, Checkered Keelback are lesser than the pre intervention period. The amphibians inhabit in various habitats from human settlement to agricultural lands and even in ditches. The frog and toad species those are commonly observed in the area are Common Toad, Indian Bullfrog, and Cricket Frog etc. Otter are not commonly seen in this area (source: local people) which was common 2-3 decades back.

A. Pallas's Fish Eagle

B. Brahmini Kite

Figure 7.2: Terrestrial Bird Species of Humaipur Haor

Source: CEGIS field visit 3rd& 4th November, 2017

Impact

The facilities provided by the intervention namely excavation embankment, sluice gate, regulators; etc has given the opportunity to other sectors for harvesting best service but for a small window of time. But in the bigger aspect it has been indirectly triggered fauna into diminishing to the threat of extinction. A specific status of the terrestrial fauna is presented in Table 7.2.

Table 7.2: Impact on Terrestrial Fauna of the Humaipur Haor Area

Indicator Species	Pre Project	Post Project	Cause of status change
Pallas's Fish Eagle	Common	Rare	Anthropogenic activities like increasing population, changing of suitable habitat etc.
Brahminy Kite	Common	Common	N/A
Vulture	Less	Extinct	N/A
Bull Frog	Common	Common	N/A
Fishing Cat	Less	Rare	N/A
Bengal Fox	Less	Less	N/A
Checkered Keelback	Common	Medium	Decreasing of suitable habitat and hunting by local people.

7.3 Aquatic Flora

Pre Project

The sample respondents opine that (those who can recall the scenario before intervention taken place), the aquatic bodies were full of different floral groups especially in Dighail Beel, Madlar Beel, Boro Kachua and Choto Kachua Beels etc. The floral vegetation like Water Chestnut or commonly called Singara (*Trapa natans*) and White Water Lily were abundant because most of the land was fallow not used for cultivation. Sometimes, flash floods occurred and made damaged to many floral communities. The diversity of flora in this area was good enough compared to current status.

Post Project

After the intervention, the floral diversity lessened for different anthropogenic activities. Present use of pesticides and population density causing harm towards the aquatic flora. Over extraction of floating, rooted or deeply rooted plants; causing threat for the diversity of this floral community. As the project area contains flowing water, water hyacinth is not commonly seen here. Nolkhagra, *Trapa natans* (commonly called Singara), and White Water Lily's lowered due to cultivation of paddy and the siltation of the beels.

Impact

The interventions for raising crop productivity have a major impact on aquatic flora throughout the project area. Some species has lost its richness and received threats to its survival namely Water Lilly, Makhna, and Chhaila Grass, Nolkhagra became rare. The Following Table represents the status of indicator aquatic plant species of the haor and their impacts over the time.

Table 7.3: Overall Status of Aquatic Flora of Humaipur Haor

Indicator Species	Pre Project	Post Project	Causes of status change/ Interventional linkage
Kochuripana	Medium	Less	N/A
Shapla	Common	Less	Anthropogenic factors
Makhna	Not grown	Not grown	N/A
Singara	Less	Rare	Anthropogenic factors
Chailla Ghash	Rare	Rare	Anthropogenic factors

7.4 Aquatic Fauna

Pre Project

Humaipur haor area was rich in aquatic faunal resources. The varied number of fish species is linked with a complex network of food web in the entire ecosystem. According to the senior respondents, the area was an ideal place for different aquatic fauna. The area was occupied with numerous local and wetland dependent migratory bird species namely Indian Pond Heron, Little Egret, Common Kingfisher, Little Cormorant, different duck species etc. Migratory bird was commonly found abundant at beel areas during winter. Ganges river dolphins were common in Ghorautra River and Dhaleshwari River. Water dependant amphibians and reptile species were commonly found in this area.

Post Project

It is obvious after field visit that, comparing with the pre-intervention scenario, the number and diversity of aquatic fauna has been decreased over time. The number of birds, amphibians and reptiles all are dropped down gradually for different factors. Whereas Indian Pond Heron, Little Egret, Common Kingfisher, Little Cormorant, Brahminy kite are commonly found in the project area. As per the sample respondents, now migratory bird species visiting is limited due to hunting and habitat change. Current status of bullfrog increased over time whereas the number of checkered keelback has been decreased due to hunting and death by fishing nets. Otter is seen less due to killing. Snail and oyster are found abundantly in the project area which is a major food source for the ducks.

A. Cormorant

B. Intermediate Egret

Figure 7.3: Aquatic Bird Species of Humaipur Haor

Source: CEGIS field visit 3rd & 4th November, 2017

Impact

Various wetlands and its different habitat characteristics support habitats for various aquatic fauna. Over the time for different anthropogenic causes the number of aquatic fauna reduced remarkably but it is evident that there is no direct connection for such loss with the intervention activities. To increase agricultural production locals use pesticides which are causing death of many aquatic faunal species.

Table 7.4: Aquatic Fauna Status of the Humaipur Haor

Indicator Species	Pre Project	Post Project	Causes of status change/ Interventional linkage
Bull frog	Common	Common	N/A
Cricket frog	Common	Common	N/A
Checkered Keelback	Common	Less	Killing/habitat loss
Eurasian Otter	Common	Less	Siltation on river bed
Migratory bird	Common	Less	Hunting/Improper insecticide use
Egrets/Herons	Common	Less	Hunting/Improper insecticide use
Snail/Oyster	Common	Common	N/A

7.5 Swamp Forest and Reed Land

Pre Project

According to senior people, Humaipur haor area was abundant with swamp forest or reed land before the intervention took place.

Post Project

The swamp forest and reed lands are gradually decreased over time after the intervention. It may be assumed that the interventions and the anthropogenic activities played a role in the decreasing of the swamp forest in the project area.

Impact

The impact due to embanking the haor area and creating protection wall around homestead area played a major role in decreasing swamp forest and reed area. The siltation of beels due to flood is another cause of the decreasing.

7.6 Ecosystem Goods and Services

Fertilizer, food, medicine, energy, fiber, construction and craft materials are important ecological goods. The ecosystem services have been divided into four categories on the basis of their nature of functions and they are provisioning, regulating, supporting and cultural services.

Pre Project

In this stage, the goods and services had not interrupted by any interventions and these were improved naturally. The provisioning services in this area had been considered as food, medicinal plants and genetic resources of the flora and fauna had been standard before implementation of the interventions. The regulating services like climatic condition were good because of vast coverage of natural vegetation as well as cultivated vegetation on settlement and crop fields. Wetlands were functioning well due to possess its natural characteristics without any intervention.

Post Project

The provisioning services have been changing day by day due to the implementation of interventions throughout the haor area. The change implies rice variety changes from local to HYV and the introduction of other vegetations which occupied largely throughout the haor area. The regulating services also interrupted via climatic change while wetland function and habitat became worse. The cultural services have also been changed. It practices tourism instead of ecotourism and hampering the aesthetic value of the haor area.

Impact

Of the above-mentioned three ecosystem services changes occurred negatively in food, medicinal vegetation and diversity, and population of flora and fauna of the depicted haor area. Similarly, unplanned establishment, also an event, occurs within the haor ecosystem.

8. Socio-economic Conditions

8.1 Introduction

The Haor system provides a wide range of economic and non-economic benefits to the local people as well as to the people of whole country at large. These benefits include rice production, fish production, cattle and buffalo rearing, duck rearing, collection of reeds and grasses, collection of aquatic and other plants. The current study has been conducted at Humaipur Haor Project area in Kishoreganj District. The socio–economic profile has been explored in this section to understand both pre and post project condition using primary and secondary data/information in line with the objectives of the study.

8.2 Location and Demography

The Humaipur Haor Project covers 5224 ha area. The area is administratively covered by 18 Mouzas of 4 Unions under Bajitpur, Austagram and Nikli Upazilas of Kishoreganj. Among them 2 Unions (Humaipur and Maij Char) are from Bajitpur Upazila and other 2 Unions (Deoghar and Gurai) from Austagram and Nikli Upazila respectively.

The study area has a total estimated population of 29418 at present (projected for 2017). Its population was only 26115 at the time of construction of this project by BWDB in 1981. Based on Bangladesh Population and Housing Census 1981, 2011 and the projected population for the 2017 the number of households, population, density and sex ratio for the year 1981 and 2017 are presented in the following table.

Table 8.1: Distribution of Population and Household in the Study Area

Time	Household	Population	Sex ratio	Density
Before Intervention (1981)	4719	26115	103	502
Present (projected, 2017)	5548	29418	99	565

Source: Bangladesh Population and Housing Census 1981 & 2011 and projected up to 2017.

8.3 Livelihood Status

Pre Project

Agriculture was the prime source of livelihoods of the majority (90%) population. Very few were involved in livestock rearing and capture fishery. The farmers depended predominantly on Local Boro rice production and the laborers were also depended on Boro farming. Production of crops yielded them their food and cash money. The livestock and fisheries were mainly the secondary sources of income. In addition, other sources of income at that period were non-agricultural labor, small business and self-employment.

Post Project

Agriculture is still the primary source of livelihoods in the study area, although its overall situation has been improved with higher yields and less damage of crops after the project intervention. According to the local people, most of the people (about 90%) are engaged in agriculture. Besides, some people are self-employed, or engaged in various types of petty businesses and other income generation activities. There are a few people who temporarily engage themselves in open-water fishing for their livelihood.

Impact

Agriculture is the main sources of income so far and the agricultural production has increased in Humaipur Haor Project area. Income opportunity based on open- water fishing has declined and only some people from the capture fishing community get access to work as a seasonal labour in culture fishery sector in this particular area. Haor leasing arrangements, which are often controlled by local elites; resulted in highly restricted access to open water fishing by the poor traditional fisherman.

8.4 Land Ownership

Pre Project

During field visit it was recorded from local stakeholders that about 12% of the households are absolute landless (i.e., having no lands either homestead or cultivated), 20% households belong to functional landless and marginal farmer (0.004 – 0.198 ha) category (i.e., having only homestead lands, cultivate predominantly by housewives mainly for household consumption), 33% households belonged to small farmer (0.202 - 1.008 ha), 28% belonged to medium farmer (1.012 – 3.032 ha) and 7% belonged to large farmer (3.036 ha and above ha) categories.

Post Project

Land holding category has changed in the post-project condition. There are some autonomous factors like population growth and distribution of property through inheritance playing the major roles in the changes of land ownership. Besides, after the project intervention the functional landless group and the small farmers gained some new lands with the increase of income through higher production of rice and income from other income generating activities like fishing, non-agricultural labor etc. At present, the ratio of land holding category is as follows: absolute landless households 8%, functional landless 26%, small farmer 40%, medium farmer 22% and 4% belong to large farmer category.

Impact

As stated earlier, in course of time, the income sources of the people of Humaipur Haor Project area have been changed. Employment opportunities have been created inside and outside of the haor. After the intervention, the crop production has increased due to the practice of high yielding crop variety using land protected from inundation of flash flood. The overall income of the farmers has, thus, increased and affordability for a better living standard is achieved.

8.5 Agriculture Crop Production Based Income

Pre Project

Livelihood opportunities for households in the Humaipur Haor Project area were limited and highly seasonal, as they were focused predominantly on agricultural labour associated with the L. T. Aman, B. Aman, L. T. Aus and Local Boro rice cropping cycle. Following Table 8.2 shows the agricultural income, based on crop production. Based on current production rate (per Ha), total agricultural income of the study area has been calculated and presented in this table. It is observed that, before the project intervention total value of the produced paddy was BDT 154.80 million and for winter vegetable it was BDT 43.9 million. In order to calculate the direct financial outcome, the present government procurement rate (Paddy BDT 21000/ton) of each crop has been taken as unit price for consideration.

Table 8.2: Crop Production Based Agricultural Income Before Intervention in Study Area

Crop name	Pre project Production(ton)	Total Value (Million/BDT)
B. Aus	480	10.1
Lt. Aus	409	8.6
B. Aman	231	4.9
Lt. Aman	1294	27.2
Local Boro	4964	104.2
Sub Total Paddy	7378	154.9
W. Vegetables	2924	43.9
Total		**198.8**

Source: Field data, 2017 through FGD, KII, and Informal Interview

Post Project

After project intervention, livelihood opportunities for households in the Humaipur Haor Project area has changed, as they have more focused on HYV Aman, HYV Aus, HYV Boro and Hybrid Boro paddy production. Additionally, the farmers were able to produce some vegetables in winter. The income opportunity based on agriculture increased and the labor group is getting additional employment opportunity, generating extra income sources for the wage earning households. The overall cropped area has also increased due to the project intervention which also increased the net crop production. After the intervention, farmers are getting BDT 383.35 million from their Paddy and vegetable crop production.

Table 8.3: Crop Production Based Agricultural Income After Intervention in Study Area

Crop name	Post project Production (ton)	Total price (Million/BDT)
Lt. Aus	285	5.99
HYV Aus	1221	25.64
Lt. Aman	834	17.51
HYV Aman	1327	27.87
Hybrid Boro	1862	39.10
HYV Boro	5682	119.32
Local Boro	2528	53.09
Sub-Total for Paddy	13739	288.52
W. Vegetables	4736	71.04
S. Vegetables	1586	23.79
Sub-Total for Vegetable	6322	94.83
Total		**383.35**

Source: Field data, 2017 through FGD, KII, and Informal Interview

Impact

Due to the project intervention additional 6361 ton of paddy and 3398 ton vegetable are being produced in the study area. Protection from early flood ensured higher yield rate of HYV paddy (Boro) and introduced cultivation of HYV Aman. Therefore, the income opportunity of agriculture based households has increased. Before the project intervention, the agricultural production based average income was about BDT 198.8 million, while after project the income has increased amounting to about BDT 383.35 million. So, agricultural production based income has been increased about BDT 184.55 million after project intervention.

8.6 Income from Agricultural Wage Labor

Pre Project

Before the project intervention, the local varieties of paddy were cultivated and it also had some vegetable cultivation in the study area. During that time there was no technological innovation or modern technology to be used for crop production. It was found that net demand for labor per ha was near about 157 person for the crop cultivation and a total number of 6.05 lac man days were needed. The following table shows the crop wise labor demand and their gross income.

Table 8.4: Agricultural Labor Demand and Labor Based Income (Before Intervention)

Crops Name	Before project		
	No. of Labor/ha	Total Man Days	Wage Income (BDT/Million)
B. Aus	130	38350	11.51
Lt. Aus	160	34400	10.32
B. Aman	135	17550	5.27
Lt. Aman	170	113390	34.02
Local Boro	170	370940	111.28
W. Vegetables	180	30600	9.18
Total/Average	**157**	**605230**	**181.57**

Source: Field data, 2017 through FGD, KII, and Informal Interview

Post Project

With the changed crop variety and intensity, the labour requirement has increased, but due to improved agricultural practices (transplanting, use of fertilizers and pesticides, harvesting and threshing) the engagement of manual labor has not increased much. From the field investigation and CEGIS estimation it is observed that total number of 6.84 lac man days on an average is needed annually. For calculating the labours' income the present local wage rate (BDT 300/day) is considered.

Table 8.5: Agricultural Labor Demand and Labor Based Income (After Intervention)

Crops Name	After project		
	No. of Labor/ha	Total Man Days	Wage Income (BDT/Million)
Lt. Aus	150	19800	5.9
HYV Aus	155	61845	18.6
Lt. Aman	150	55350	16.6
HYV Aman	155	63705	19.1
Hybrid Boro	170	64600	19.4
HYV Boro	160	224480	67.3
Local Boro	165	152460	45.7
W. Vegetables	170	31450	9.4
S. Vegetables	165	10725	3.2
Total/Average	**160**	**684415**	**205.3**

Source: Field data, 2017 through FGD, KII, and Informal Interview

Impact

The working opportunities for agricultural labor were limited before project implementation as agricultural activities were conducted mainly manually. After project intervention, people got enabling environment to grow more paddy by introducing HYV crop varieties with intensive land-use. Therefore, additional 79,185 labor man days has required now which comes mostly from the local labor community. The direct impact on agricultural wage based income for the laborers has increased BDT 23.76 million.

8.7 Accessibility to Education and Health Services

Pre Project

Before intervention, the health and education services for the people of Humaipur Haor Project area were not accessible to all. During the rainy season, primary education was frequently disrupted during floods almost every year. People used boat to go to schools and health clinics while walking was the only choice when boat could not ply. Schools remained closed for about 70 days on average every year due to flooding. The school houses were used as flood shelter for the affected people. On the other hand, students living in distant area usually used to drop their classes due to unsafe communication during monsoon. Besides, the flood- induced poverty also increased the number of drop-out students in this haor area.

Post Project

Health and educational institutions (both in number and services) have increased with time. People, especially school going children have become enthusiastic to go to schools run under different Govt. and NGOs programs. Besides, since the submergible embankments constructed, local people, school going children, pedestrian, women and other people have been using it as road especially, in the dry season. Presently, when some of the locations of the embankments are damaged, people’s way to reach to the schools and health institutions are reported to be hampered for a certain period. But in wet season, deferent types of boats are the main sources of transportation for going to school and health centre.

Impact

Direct impact of the construction of Humaipur Haor Project area on literacy and health are marginal, but indirectly, the submergible embankments are serving as road for getting easy access to schools and clinics during the dry period. Patients on emergency can be taken to clinics by using local vans or rickshaws along the embankment in dry season as alternative roads do not exist. The indirect benefit to education and health services is the increased affordability of small and medium farm households to avail those services with their increased agricultural and ancillary income due to protected crops and other resources from damage as an effect of early flood control and drainage infrastructures.

8.8 Land Price

Pre Project

Before intervention, the land price of this Haor region was minimal and people were not interested to buy land due to regular flash flood and crop damage. It is reported by local people that the price of agricultural land was BDT 12000 to 15,000 per *Keyar*[1] and BDT30, 000 to 40,000 per *Keyar* for homestead land before the project.

Post Project

With the project-induced change and autonomous development in the whole Haor region the earlier situation has changed and the land price has increased over the time. After the project intervention, the land price has increased due to the increased productivity of land and improved communication system. Though exogenous factors like macroeconomic development and inflation have contributed to raise the land price, people's interest to buy those lands are acknowledged to be one of the reasons of rise in land price. Presently, the price of agricultural land per *Keyar* is around BDT 40,000 to 50,000 whereas the price of homestead lands learnt as BDT 120,000 to 130,000 per *Keyar*.

Impact

Protection from flash flood enabling environment for HYV rice culture and intensity of land use has increased the value of land by more than three or four times than the pre-project price. On an average about BDT 20,000 has been increased for agricultural lands and BDT 70,000 for homestead lands. Asset value of land has increased for all land owning households, making them more credit worthy for more assets to own.

8.9 Transport and Communication

Pre Project

Before intervention, people mostly used boat (either engine or country) during the rainy season, and no specific transportation system was available during the dry period. People used to go to their desired places mostly on foot in the dry season. The roads for using any kinds of vehicle were not available. Most of the social occasions were held during rainy season only to avail opportunities of using water way.

Post Project

After the period of project intervention, people started to use the constructed submergible embankment as road to go to school, connecting highways, bazaar and health centre etc. Though those embankments were not suitable for driving automobiles, people got opportunity to ply with auto rickshaws and bikes during the dry season. But in wet season, engine boat is the main sources of transport and communication in this region.

During last 5 to 10 years, the recurring damage to the submergible embankments have left the school going students, pedestrians, children and women with problems to use those embankment even as walk way during the early monsoon period.

Impact

The communication system has been improved as the Humaipur Haor is very close to the Upazila Headquarter. The BWDB's submersible embankments and compartmental dykes are playing major roles in communication though these are damaged after each flood season. Now a day, due to erosion of the embankments and dykes, sufferings of the people

[1] 1 Keyar = 30 decimals

have become beggar’s description. Between the wet and dry season, the sufferings increased many folds because both road and waterway remain unfeasible for human beings to use.

8.10 Labor and Seasonal Migration

Pre Project

People did not get access to any other work than in agriculture before the project intervention. People from different regions of the country came to join as labor work force for crop harvesting and fishing. The intensity to come during that period was significant and people’s demand-specific labors within the haor area were not adequate to carry out their agricultural activities. The technological innovation for agricultural production was not significant at that period. Use of transplantation system, pesticides, insecticides, fertilizers etc. were almost unknown. It was found that net demand for labor per ha was roughly 157 per ha. and 60% of the labor came from outside of the locality.

Post Project

After the project intervention, as the agricultural production has increased, better livelihood and employment opportunity for wage labor has increased too. The net demand for agricultural labor (having with technological innovation) is roughly 160 per ha. So, average labor input has increased due to the introduction of high yielding variety and crop diversity which requires more maintenance for better production. But, still now about 25% labors migrate from other regions during the harvesting period.

In a cropping season when the working opportunities are available, wage laborers rarely migrate outside of their locality and instead in-migration takes place during that time. During last ten years people have been facing regular damage due to flood and water logging, in this way, people who were dependent on agriculture for livelihood were forced to migrate to neighboring districts for better livelihood. During the flash flood, people of this Humaipur Haor Project area try to find other opportunity to render labor as motor driver, garment workers, rickshaw puller in Netrokona, Mymensing and Dhaka city areas.

Impact

As a result of increased income from wage, relatively poor labor households of study area have become able to raise their living standard to some extent. Opportunities of wage income for labor households also have increased beyond this haor due to similar developments in agriculture sector. Therefore, the net impact of the project on income and living standard of labor households of Humaipur Haor Project area is positive.

8.11 Institution and Governance

Bangladesh Water Development Board (BWDB) was responsible for physical implementation of water sector projects through constructing relevant infrastructures in the haor region. The Local Government Engineering Department (LGED) has also small-scale interventions and projects in some areas of haor region. Of late, Department of Bangladesh Haor and Wetland Development (DBHWD) has been created. As apex institutions, these three have been administering all plans and projects in haor region.

Pre Project

Before the project intervention, Local Government Institutions (LGIs) like Union Parishad and Upazila Parishad existed with mandate to look after haor water and wetland resources. Inundation either by early or by monsoon flood water was almost a regular phenomenon in the haor area. Leasing of *Jalmahals* (water bodies) was the prime activity of those LGIs for raising revenue in favor of the government. It was only after BWDB was engaged that the issues of water development and wetland management came in.

Post Project

After the project implementation, BWDB started to develop, manage and monitor the project activities in Humaipur Haor Project area. Their role for Operation and Maintenance (O&M) was regular with the completion of submergible embankments, drainage sluices and inlets/outlets. Presently, it has been found from the consultation sessions with the primary stakeholders that the responsible institutions specifically BWDB is visible only during the period of post-flooding. As per stakeholders' opinion, BWDB along with PIC[2] used to monitor the physical condition of the infrastructures to assess their damages and to plan for repair before the next flood season. According to the local people, the officials from these institutions did not consult adequately with the local people for lessening the recurring damage of the submergible embankments by carrying out repair works properly.

Impact

The presence of BWDB and the PIC has some institutional impact on the beneficiaries of the Humaipur Haor Project. Overseeing the operation and maintenance of the infrastructures is the main function of those institutions. But the condition of physical infrastructures of the haor is reported to be running below the desired level.

[2] PIC (Project Implementation Committee) is formed by BWDB taking support of LGIs for assessing, planning and carrying out the annual repair-maintenance work of specific Haor Scheme/Project. PIC comprises of Chairman and Members of Local Union Parishads, representatives from local elites and beneficiaries, with total number of 5 to 7 members. UP Chairman or UP Member is the Chairman of PIC, where 1 (one) membership is reserved for women to represent and ensure their interest. Other than, UP Chairman and Members, representatives from local elites, beneficiaries and women are selected in consultation with UNO.

9. Summary of Impacts

Table 9.1: Summary of Impacts

Indicators	Pre project	Post project	Impact
Water Resources			
Flooding	▪ The haor area was subjected to heavy flooding before the project. ▪ It was quiet impossible do protect the agricultural land from flooding during that time.	▪ The embankment surrounding the haor has helped a lot to protect the agricultural land from flooding for 4 decades. ▪ However, the embankment has started losing its section since 90s due to wave action making it difficult to encounter flash flood	▪ The interventions have helped to protect the haor area from flooding. Due to degradation of the embankment, the project area in recent time has become vulnerable to inundation.
Drainage and Sedimentation	▪ Drainage and sedimentation were not major problems before the project. ▪ Water could easily pass through the entrance and exit point of the haor taking the sediment with it.	▪ After the project, the condition of drainage and sedimentation have remained almost the same. ▪ The passage of water from haor through the river and connecting khals does not face any problem and the heavy flow of water washes the sediment from the river and haor bed along with it.	▪ The impact on drainage and sediment have not been affected.
Erosion	▪ Humaipur haor area was not subjected to severe erosion before the project. ▪ The northern part of the haor faced a little erosion problem before the project.	▪ Erosion problem has increased a lot after the project. ▪ The western side of the haor has become more vulnerable to erosion compared to the north side.	▪ The erosion has engulfed a whole village as well as 200-250 acres of land of the haor in the river.
Navigation	▪ Navigation in Humaipur haor was very less. ▪ People used water vessels mostly for personal purposes, few moved for commercial benefits.	▪ Public cuts are made in the pre-monsoon period to have access to river from the haor. ▪ Different modes of water vessels are now seen moving in the haor area for both personal and commercial purposes.	▪ The navigational connectivity between the haor and the peripheral rivers does not persist in pre-monsoon period due to submersible embankment ▪ Both the number of navigation routes, water vessels and types of water vessels have increased after the project that operate

Indicators	Pre project	Post project	Impact
			in the peripheral rivers.
Land Resources			
Land use (ha)	▪ Gross area: 5,224 ▪ i) NCA : 5,063 ▪ ii) Others:161	▪ Gross area:5,224 ▪ i) NCA: 5,039 ▪ ii) Others: 185	▪ i) NCA: -24 ▪ ii) Others: +24
Land degradation (Sand Carpeting area), ha	NA	NA	NA
Agriculture Resources			
Cropping intensity (%)	100	100	No change
Cropped area (ha)	▪ Rice: 5,063	▪ Rice: 5,039	▪ Rice: -24
Crop production (ton)	▪ Rice: 10,987	▪ Rice: 20,373	▪ Rice: +9,386
Crop damage (ton)	▪ Rice: 3,190	▪ Rice: 4,846	▪ Rice:+1,656
Surface water Irrigation availability	▪ Available	▪ Deficit during month of February to March	▪ Deficit
Agro-chemicals use (ton or kilo litre)	▪ Fertilizers: 0 ▪ Pesticides: 0	▪ Fertilizers: 1557 ▪ Pesticides: ▪ i) Granular: 11 ▪ ii) Liquid:7	▪ Fertilizers: +1557 ▪ Pesticides: ▪ i) Granular: +11 ▪ ii) Liquid:+7
Livestock Resources			
Livestock population (number)	▪ Cattle: 6,870 ▪ Goat: 2,480 ▪ Chicken: 37,760 ▪ Duck:13,860	▪ Cattle: 8,670 ▪ Goat: 1,860 ▪ Chicken: 34,070 ▪ Duck: 11,620	▪ Cattle: +1,800 ▪ Goat: -620 ▪ Chicken: -3,690 ▪ Duck: -2,240
Fisheries Resources			
Fish habitat area	▪ Fish habitat was about 5161 ha. ▪ Of which capture 5156 ha. ▪ Culture 5 ha	▪ Total fish habitat is 5169 ha. ▪ Of which capture 5167 ha. ▪ Culture 2 ha.	▪ Overall increase the fish habitat 8 ha. ▪ Increased the capture fish habitat area 11 ha. ▪ Decreased the culture habitat 3 ha.
Habitat Condition	▪ Fish habitat quality and water quality was better. ▪ Some water bodies was untouched from fishing for next year recruitment of fishes. ▪ Agrochemicals, pesticides and fertilizer wereused in crop field were limited.	▪ Degrading the habitat quality as well as water quality in the haor because of incremental use of agrochemical in the boro field. ▪ Increasing the pollution in water due to wastages from homestead, market and other sources.	▪ Fish habitat condition and water quality. Water also polluted by wastage from different sources of adjacent areas.
Fish Diversity	▪ About 110 fish species was available in Humaipur haor area.	▪ Changing of abundance of some fish species but species are almost same.	▪ Abundance of fish species are changing and big species are decreasing day by day.
Fish migration	▪ The fishes move easily from one place to another without any disturbance. Fish migration was smooth.	▪ Raising of bed level by silt and manmade activities of connected khals and disturb fish migration.	▪ Breeding of small fishes are delayed in some extent due to hampering of fish migration and movement.
Fish Production	▪ Overall fish production was 1057 MT per	▪ Total fish production is about 1325 MT per	▪ Increasingof fish production about 268

Indicators	Pre project	Post project	Impact
	year. ▪ Of which from capture production was about 1053 MT. ▪ From culture production was about 4 MT.	year. ▪ Of which from capture production 1323 MT. ▪ From culture production about 2 MT.	MT per year.
Fishing Appliance	▪ Types of fishing gears namely ber jal, khora, koi jal, puti jal, jhaki jal, dharma jal, thela jal, borshi, Gui wereused to catch the fishes. ▪ The mesh size of net and gears was about 2 and 3 cm whichwas fish friendly.	▪ Gears are almost similar. At present the fishers are using some new net like moshari jal damaging the fish fry as well as fish habitat. ▪ Moshari jal and Kironmala are used to catch fish which are not fish friendly and destroy the small fishes and fish habitat.	▪ Decrease the habitat productivity and richness of fish.
Fishers livelihood	▪ Mostly Hindu fishers' was involve with fishing and number of Muslim fishers was almost absent. ▪ The fishers maintain their live smoothly.	▪ Fishers' numbers are increasing day by day. Mainly increased the part time fishers rapidly. ▪ Numbers of peoples are involved (based on fisheries resources) with various activities like fish aratder, retailer, ice producer, fish labor, transport worker etc. for their livelihood.	▪ Increasing the participation of several types of communities. in fisheries activities. ▪ Fishing pressure on haor areas are increasing day by day. And the real fishers are shifting from their position due to rapid entrance of other fishers.
Fisheries Management	▪ Some beel area was kept to protect the brood fish for next year breeding. ▪ The professional fisher never catch fish by de-watering or any brood fish.	▪ Fishing is open for everybody in monsoon. ▪ But in post monsoon, fishing are not allow in the privately own beel, katha / jatha and its adjacent area.	▪ Fishing access is limited especially in privately own beel, katha / jatha and adjacent area in post monsoon period. ▪ So professional fishers are not getting full benefit in post monsoon period and shifting from their profession.
Ecosystem			
Terrestrial flora	▪ Indicator species were common	▪ Indicator species were common or occasional	▪ Insignificant change
Terrestrial fauna	▪ Status was common for most of the indicator species	▪ Status have been changed	▪ Reduction of few species due to hunting; killing etc. though intervention is not responsible

Indicators	Pre project	Post project	Impact
			directly
Aquatic flora	▪ Indicator species were common or occasional	▪ Status have been changed over time	▪ Reduced coverage most of the species due to Agricultural expansion, over exploitation and fishing activities
Aquatic fauna	▪ Indicator species were common	▪ Status have changed in few areas	▪ The number of checkered keelback has been decreased due to hunting and death by fishing nets. Snail and oyster are found abundantly in the project area which is a major food source for the ducks, Migratory bird and other wildlife reduced due to hunting agricultural extension and habitat destruction etc.
Swamp Forest and Reed land	▪ Swamp forest was in optimum level and reed coverage was also good.	▪ Coverage of swamp and reeds has been decreased over time	▪ Change coverage of reed beds due to expansion of cropping intensity
Ecosystem goods and services	▪ Optimum	▪ Reduced	▪ Provisional services has boosted up and regulating and cultural services has reduced
Socio-economic Conditions			
Employment Opportunity	Total cropped area was 5063 ha whereas about 6.05 lac man days labour inputs were needed.	Total cropped area were 5039 ha where about 6.84 lac man days labor input are needed	▪ Additional 79,185 labor man days has been employed due to the change in the crop variety and cropping intensity which was possible only for project intervention. ▪ Employment opportunity has also been created during the period of O&M in Humaipur Haor Project Area.
Agriculture production base income	The total agricultural production value at current price was BDT 181.57 million	The total agricultural production value at current price is BDT 383.35 million	Agricultural production base income has increased due the project intervention up to BDT 184.55 million
Agriculture wage base income	The agricultural wage base average income was about BDT 181.57 million.	The agricultural wage base average income is about BDT 205.3 million	Agricultural wage labor income increased up to BDT 23.76 million after project condition.

Indicators	Pre project	Post project	Impact
Labor and Seasonal Migration	The demand for labor per ha near about 157 and maximum labor came from outside than the locality.	The demand for agricultural labor is near about 160 per ha. and labor in-migration has decreased and local labors are employed	Local wage earning households within the project have more employment opportunity and their socioeconomic situation has slightly improved with more wage income.
Land Price	The price of agricultural land was BDT 12000 to 15000 per Keyar and that of homestead land was between BDT 30,000 to 40,000 only	The price of agricultural land is near to be BDT 40,000 to 50,000 per Keyar whereas the price is BDT 120,000 to130,000 for homestead lands.	Asset value of land has increased for all land owning households, making them more credit worthy for more assets to own.
Accessibility in Health and Educational institution	▪ It was tough to go to schools and health institutions especially the periods in between the wet and dry season.	▪ People started to use the submersible embankments as their way of communication. ▪ With the damage of certain locations of the embankments people felt in-secured to use their way of moving ▪ School going children sometimes faced problem in using breached embankments on their way to schools.	▪ The communication system ris comfortable for people comfortable at least during dry season but frequent breaches have left them uncertain about using embankment as road as long as these are not submerged.
Institution and Governance	▪ Local Union Parishad used to manage local water bodies (through lease out) and large Beels and Haors were managed by Deputy Commissioner at district level.	▪ The institutions (i.e. BWDB) constructed embankments and has been conducting O&M of infrastructures ▪ Local people's participation in planning and management has been insufficient and hence governance ineffective.	▪ Institutional presence (of BWDB) is seen but efficiency of flood control system is at the low ebb. ▪ In absence of participatory management body within Haor, the governance position does not turn out meaningful.

10. Environmental Management Plan

Table 10.1: Management Plan

Impact	Mitigation Measures	Enhancement Measures
Flooding	▪ The damaged embankment should be repaired as soon as possible. ▪ New embankment near Madla and Aynar Gop should be constructed as old embankment has been eroded. ▪ The embankment on the north side of Humaipur village should be raised to stop the entrance of flood water. ▪ Awareness should be raised among the people of the haor against public cutting.	
Drainage and Sedimentation	▪ The connecting khals at few places should be excavated to maintain smooth drainage and tackle sedimentation of the haor.	
Erosion	▪ The vulnerable part of Humaipur Village should be protected properly from erosion. ▪ The embankment should be strengthened and protected to combat erosion.	
Navigation	The peripheral rivers at few places near the Humaipur should be excavated to have more access to adjacent villages.	
Land use change	Land use policy should be practiced.	-
Decreased cropped area	▪ Kanda should be utilized for vegetables cultivation. ▪ Hydroponics or floating bed vegetables cultivation should be introduced or strengthened. ▪ Medium low land should be utilized for short duration and submergence tolerant T Aman (BINA dhan7, BINA dhan 11, BINA dhan12 and BINA dhan 13) cultivation. ▪ Flood tolerant submergence variety (BRRI dhan51, BRRI dhan52 and BRRI dhan79 may be tested.	-
Increased crop production	-	▪ Crop area should be increased by utilization of fallow land. ▪ Short duration high yielding and hybrid varieties should be developed/introduced/strengthen ed. ▪ Crop damage should be minimized by timely and proper

Impact	Mitigation Measures	Enhancement Measures
		rehabilitation of water control structures like embankment, regulators, drainage sluices etc.
Decreased irrigated area and Availability of irrigation water	Regular re-excavation/dredging of the Ghra Utra River and Dhaleswari River has to be ensured in order for retention of irrigation water.	▪ Re-excavation of existing beels and khals should be ensured for retention of irrigation water. ▪ Irrigation water should be ensured by stopping draining out of the Beels during early dry season for fish harvesting.
Status of livestock/poultry	-	▪ Grazing area should be increased by utilizing fallow land. ▪ Awareness build up through training ▪ Marketing facilities should be improved. ▪ Availability of high yielding breed should be ensured.
Increased crop damage	▪ Height of the embankment should be improved as per design level. ▪ Repairing of embankment at Chhatir char, Char Dighirpar, Parkachua, Patli, and Salpan. ▪ Overall whole of the embankment is to raised up to 4-7 ft. height through earthwork from existing level of the embankment for saving boro crops. ▪ Regular maintenance work is needed on compartmental embankment by BWDB. ▪ Embankment should be repaired during November to December. ▪ Regular dredging of the rivers has to be ensured in order to reduce the intensity of flash flood. ▪ Rehabilitation works should be finished by February ▪ Quality materials should be used for rehabilitation works. ▪ Short duration high yielding or hybrid varieties should be used instead of long duration BRRI dhan29 variety. ▪ Local varieties should be transplanted in the deeper part of the haor area instead of short height high yielding or hybrid variety.	
Increased use of agro-chemicals	▪ Farmers should be encouraged to use organic manure to increase soil fertility while avoiding water contamination and reduce the soil fertility. ▪ Farmers should be encouraged to cultivate leguminous crops to enhance the soil quality. ▪ Farmer should follow modern	

Impact	Mitigation Measures	Enhancement Measures
	agricultural technology like Integrated Pest Management/Integrated Crop Management(IPM/ ICM), Good Agricultural Practices(GAP) etc.	
Changing of fish habitat and water quality.	▪ Fishing by moshari jal should be banned round the year. ▪ Optimum use of agrochemicals and pesticides and fertilizer in crop field. ▪ Fishing by dewatering should be stopped.	▪ Fishing by moshari jal should be banned permanently. ▪ Demonstration of optimal use of agrochemicals in crop field should be conducted by the Department of Agriculture Extension (DAE) of respective upazila.
Decreasing of the species richness and declining of some fishes.	Fishing by de-watering and moshari jal should be bannedround the year.	▪ Mainly local fishers' communities in coordination with local elites / leaders should conduct monitoring to protect the fishing by moshari jal and guided by the related upazila fisheries officials.
Hindering of fish migration.	For smooth migration from river to beel or floodplain gates of regulators should be open in pre-monsoon and monsoon period.	▪ Removal of silt from the Ghora Utra river through dredging. Repairing of regulator (as required) and proper maintenance should be conducted by regulator management committee. ▪ Management committee (for regulator operation) should be formed by 7 or 9 members from the adjacent village. The committee members are local land owner, farmer, elite, and teacher, UP member, fishers and other community members. At least 1 fisher members should be present in regulator operation committee.
Day by day increasing of the fishing pressure.	Only the ID card holders' fisher should allow for fishing round the year.	▪ Related Upazila Fisheries Officer (UFO) should provide the ID card to the fishers as early as possible (if not complete the distribution). ▪ New ID card should be provided by the UFO to the new fishers through proper judgment by the old ID card holder fishers in coordination with the local elites.
Decreasing of perennial beels/water area.	Removal of silt from the adjacent river through dredging.	▪ Management committee (as mention above) should protect the water bodies and proper maintenance of regulator. ▪ Aware the local community about the importance of wetlands through different program.
Reduction of terrestrial vegetation and wildlife population	▪ Increase people awareness about wildlife conservation ▪ Initiate Govt. to conserve respective amount of natural vegetation and reedland in each haor area	Initiate plantation program along the river levees, kandas and other khash lands

Impact	Mitigation Measures	Enhancement Measures
Reduced coverage of most of the aquatic floral species	▪ Control over harvesting of aquatic resources ▪ During any development work aquatic resources should be strongly considered and over exploitation should be stopped	
Reduce, Migratory Birds and other aquatic fauna	▪ Identify the core habitat for the threatened animals and take action to conserve the respective habitats ▪ Facilitate commercial snail culture to meet up the duck feed demand	Aware local farmers for using optimum doses of fertilizers and insecticides
Change coverage of reedbeds due to expansion of cropping intensity	All the khash land with swamp forest and reedlands should be out of public lease and allotments	
Provisional services has boosted up and regulating and cultural services has reduced		Awareness among people should be increased regarding this issue.
(Livelihood and employment opportunity) ▪ New employment opportunity has been created with the increase of agricultural production ▪ Employment opportunity has been created during the period of Operation and Maintenance (O&M) of the interventions in Humaipur Haor Project area.	**-**	▪ Training would be ensured for the creation of alternative livelihood options ▪ Submergible embankment must be repaired using the local labor ▪ Allocation of all beel /Jallmohal to the actual fishermen on equity basis ▪ Soft loan should be provided especially duringthe emergency period (i.e. post flooding condition) ▪ Build up linkage with farmer and national, international traders.
(Agriculture and wage based income) ▪ Agricultural production based income increased due to the project intervention. ▪ Agricultural wage labor income increased with project.	-	New variety of crops and its profitable production should be ensured among farmers. Appropriate training programs should be initiated for farmers to cope up with the changing climate and technology
(Labor and Seasonal Migration) ▪ The demand for skilled and unskilled labor increased during O&M of project.	-	Skill development training program should be initiated for capacity building especially for men and women to enable them to continue with the skill as livelihood opportunity in similar construction works.
(Land Price) ▪ The opportunities for agricultural production	-	Regular Operation and Maintenance (O&M) and riverbank protection work should be continued properly to keep the land

Impact	Mitigation Measures	Enhancement Measures
increased for which the value of agricultural lands is also increasing		optimally productive.
(Accessibility to Health and Educational institution) ▪ The submergible embankments provided opportunity to be used as road with project intervention. ▪ Due to lack of proper maintenance, the damage of the embankments has increased and local people started to face problem to use these embankments as their means of communication.	-	▪ A functional monitoring team should be formed in association with BWDB and local beneficiary people to identify damaged parts of the embankment ▪ Local beneficiary participation should be ensured in repair/maintenance of minor damages to embankment.
(Institution and Governance) ▪ There is no mechanism to consider local people's ideas and concerns while drawing project operation and maintenance systems. Project people suffer crop loss and other household vulnerabilities. ▪ The role of institution to consider public demand in policy, operation and maintenance on the issue of those submergible embankments.	▪ PIC should be more functional for performing annual O&M activities ▪ Quarterly meeting should be initiated by BWDB-PIC with Local Water and Flood Protection Committee to understand the gap of institutional policy and governance ▪ A functional monitoring team should be formed to visit submergible embankments periodically ▪ People's feedback should be taken before the implementation of any kind of policy in relation to new project and maintenance and operation of those submergible embankments.	Haor Rakhkhaya Committee (Haor Water and Flood Protection Committee) may be formed in each village to identify damaged parts of the embankment jointly with BWDB-PIC as well as monitor and supervise the activities of BWDB-PIC.

Appendix-A: Photo Album

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Kalikota Haor Project

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1. Introduction

1.1 General Information

The Kalikota Haor project is located in between 24°43'10.18 N" and 24°52'54.17 N" latitude and between 91°08'37.56 E" and 91°21'56.41 E" and lies within Sunamgonj, Kishorgonj and Netrokona Districts. The project area covers around 17800 ha. There are several haors adjacent to this project, namely Pagna haor located at the North, Baram haor at the East, Chaptir Haor at the south-east, Chayer Haor at the south and Chandra Sunarthal Haor at the west.

The main river connected with Kalikota haor is the Surma which flows along its north-east peripheries. Besides, a branch of Surma river known as Mora Gang and Darain River flows along the south-east direction, Piyain and Baulai river at the west. There are a number of canals and wetlands inside the Kalikota Haor project. Mentionable are Kalikota khal, Fera-ban khal, Fawar-ban khal, Kolkolla-ban khal, Haowar khal, Shoutta khal, Haira khal, Banda khal, Khirai khal, Norshi khal which help to drain out the water of the haor during post monsoon. Moreover, these khals connect the internal beels of the haor. Mentionable beels are Jalaldi Beel, Bara Beel, Ainal Beel, Katgang Beel, Chata Beel, Banda Beel, Dhuli Beel, Khali Beel, Gatua Beel, Agra Beel, Panda Beel, Maoa Beel and Konarmukhi Beel.

1.2 Project Descriptions

Bangladesh Water Development Board (BWDB) implemented the Kalikota Haor Project during 1978-1993 with GOB fund. The main objective of the project was to protect Boro crops from early flash flood as well as to protect life and properties from flooding. The water management infrastructures of the Kalikota Haor Project include the following:

- Embankment: 77 km including compartmental embankment;
- Regulator: 2 Nos.;
- Pipe sluice: 3 Nos;
- Culvert: 6 Nos. in compartmental embankment.

Figure 1.1: Regulator at Balanpur

1.3 Present Status of the Project Interventions

Major interventions include submergible embankment and some different types of appurtenant hydraulic structures like regulator, culvert, bridge and pipe sluice. Submersible Embankments are the most common structural interventions in this region. It is observed that along majority part of the embankments, the crest level recedes from the design crest level, existing cross-sections receive damage compared to design cross-section and breaches of embankments are found at numerous locations Breaches allow water entrance into the haor areas before harvesting of boro crops is done leading to severe damage to the crops. Moreover, Public cuts have been observed at different locations along the embankments due to water drainage. Submersible embankment with Lowered crest level is incapable of serving its purpose. In this haor, considerable numbers of culverts and two regulators have been observed. The regulator at Balanpur is functioning well, however the other regulator at Daudpur is in non-functional state. Reasons behind low or non-functionality of hydraulic structures include: poorly fitted gates resulting to seepage flow, stresses relating to mechanical operation and missing of some valuable components of gates and hoist system, silted up linked canal creating drainage congestion etc.

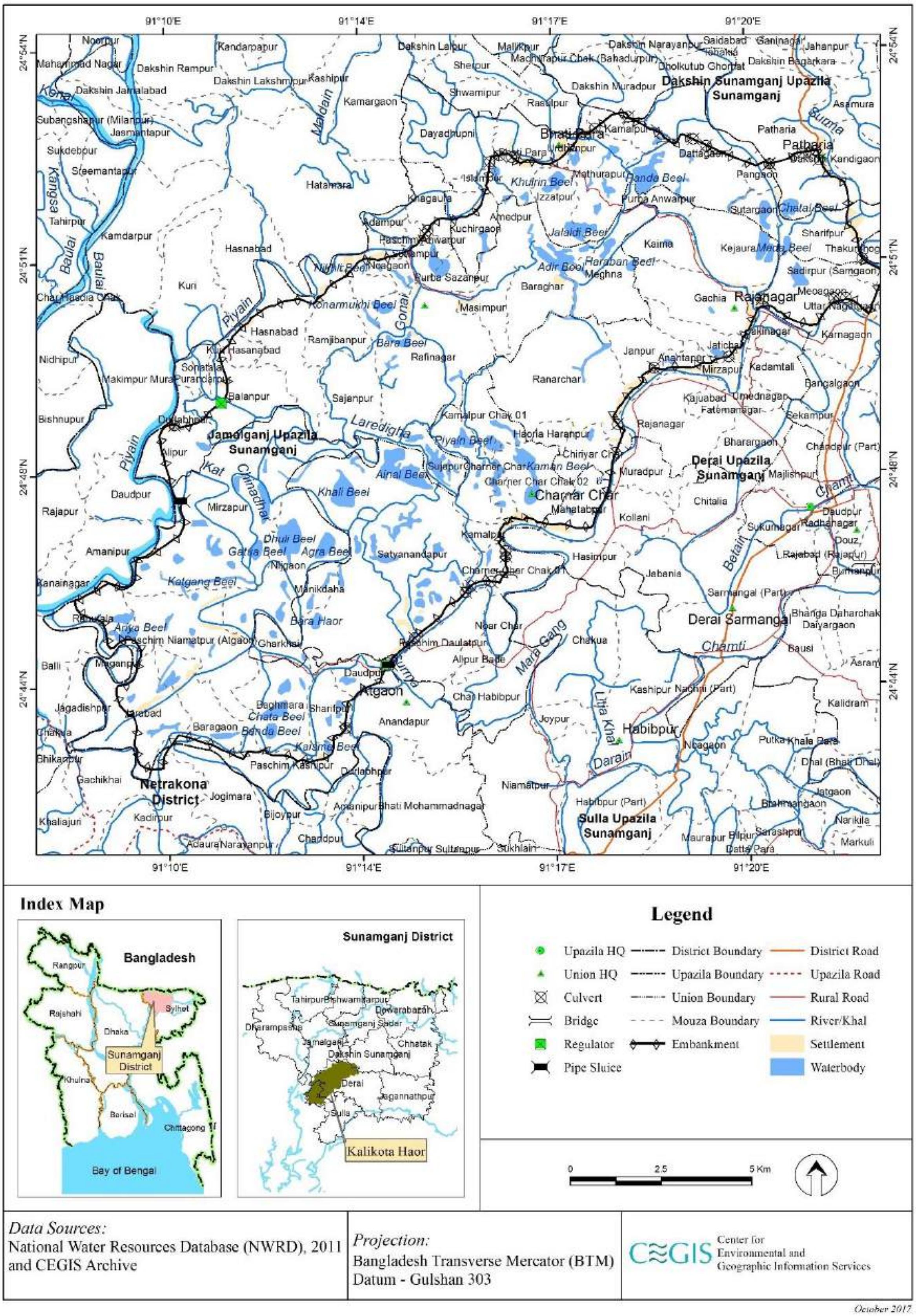

Figure 1.2: Hydrologic features of Kalikota Haor

2. Water Resources

2.1 Flooding

Pre Project

Before implementation of the project, flash flood frequently entered into the haor during middle of March to early April through the Surma and Piyain rivers. This flash flood caused severe damage to crops and livelihood of the Haor populace. To tackle the problem, local people made temporary earthen dam across the khals so that they could harvest their standing crops. Local people informed that the devastating flood in 1998 engulfed the entire project area and caused huge damage to standing crops as well as immense sufferings to the people of this area.

Post Project

After implementation of submersible embankment in Kalikota Haor, entrance of flood into haor got delayed by 9-10 days. The flash flood enters through khals as well as by overtopping the submersible embankment in last week of April and inundates the entire project area within a week. The local people informed that after implementation of the embankment, they could harvest their crops and safeguard the livelihood due to delayed inundation by the flash flood.

However, the flash flood sometimes comes early due to unprecedented rainfall in the upper catchment in Meghalaya which happened in 2004 and 2017 in March. The devastating flash floods inundated the entire haor area in the first week of March and damaged all the standing crops. It caused immense sufferings to the local populace. Some segments of the embankment were breached at that time. At present, the crest level of the embankment of Islampur, Pangaon and Kamalpur was found to be below the design level. As a result, flood water enters the haor through these areas within 6 to 7 days which is supposed to enter after 9 to 10 days from its occurrences. As a result, flash flood causes crop damage and sufferings to the people every year.

Figure 2.1: Kalikota Haor in Wet season

Impact

Interventions of the haor have delayed the entrance of flood water by approximately 9 to 10 days. However, in recent years, delay of entrance of flash flood has reduced due to delayed repairing of embankment and closing of breaches or public cuts on embankment. Local people demanded that the repairing work should be done within February to avoid the hazard of flash flood.

2.2 Drainage Congestion and Water Logging

Pre Project

There are a number of drainage khals inside the Kalikota haor which helped drain out the flood water. According to the local people, in pre-project period most of the flood water could smoothly be drained out to the peripheral rivers through the drainage khals and only some water got retained in the low-lying beels. People made several earthen dams across the internal khals to preserve water for irrigation during dry season. They did not face drainage congestion and water logging problem at large scale before implementation of the interventions.

Post Project

After implementation of the project, the drainage system of the haor has little bit deteriorated. The flood water is being drained out through the peripheral rivers as well as through regulators at Balanpur and Daudpur constructed around 25 years ago. Local people informed that around 40% areas of Manikdaha, Baragaon, Baghmara and Shafipur Union faces water logging problem for about 7 to 9 days. Besides, the upstream region namely Izzatpur, Ranarchar, Amedpur and Purba Anwarpur Union do not face drainage congestion problem. Moreover, earthen dam constructed by local farmers around Jalaldi Beel slows down the water velocity towards the low-land. Sometimes local people intentionally cut some segments of the embankment for smooth drainage. BWDB carry out the repairing works of embankment every year to protect from flash flood. Most of the area of the haor gets dried up within last week of January. The internal District roads constructed by LGED does not affect the drainage of the haor area.

Impact

The drainage of the area has become slower than before but not impacting at appreciable extent. Local people demanded for sluice gate maintenance for smooth drainage of the area.

2.3 Sedimentation

Pre Project

Sedimentation was not a significant issue in this haor. The Surma River carried very low sediment. Hence, sedimentation of this haor was not that much problem before implementation of the interventions.

Post Project

Sedimentation takes places in this haor in natural process. However, sedimentation has taken place in the internal river namely Surma and Piyain river and khals over the years due to slow drainage after monsoon. As a result the bed level of the rivers and khals has risen and reduced their conveyance capacity.

Impact

Sedimentation has increased in the peripheral Piyain and Surma riverS as well as internal khals compared to the pre-project condition.

2.4 Navigation

Pre Project

During pre-project period, there was navigational connectivity between the haor and the Surma and Piyain river throughout the year.

Post Project

Navigational connectivity of the haor and peripheral rivers like Surma, Mora-Gang, and Piyain mainly remains operative during monsoon. Besides, navigation also operates through the breached points (if occurs) and public cuts before repairing in February/March. Moreover, boats can ply within the haor for fishing and other purposes. Moreover, navigation in the peripheral river has not been affected. However, navigational connectivity does not persist during pre-monsoon due to repair of submersible embankment.

Impact

The navigational connectivity between the haor and the peripheral river has not been affected in monsoon but it does not operate during pre-monsoon. Moreover, navigation in the peripheral river has also not been affected.

3. Land Resources

The project area has fallen in one Agro-ecological zone, namely: Sylhet Basin (AEZ-21). Non-calcareous grey floodplain soil (non-saline) is the dominant soil. The top soil texture are clay and clay loam; where clay texture is dominant. The soils are slow permeable and have a medium moisture holding capacity. The land type characteristics are not uniform within the project area. About 77% of cultivable areas are low to very low land where minimum flooding depth is above 1.8 meter during the monsoon period. The recession of surface water from most of the agriculture land starts at middle of December and become free of flood water in late January.

Two indicators (Land use and Sand carpeting area) have been selected for assessing the impact on land resources due to structural interventions in Haor ecosystem. The land use and sand carpeting information under pre-project and existing situations were identified through analysis of the available archived satellite images of CEGIS and it was verified through Focus Group Discussion (FGD) and Key Informant Interview (KII).

3.1 Land Use

Pre Project

The gross area of pre project has been considered as similar to post project. The gross area was 17,799 ha under pre-project situation of which Net Cultivated Area (NCA) was 14,984 ha. The rest area was covered with water bodies (Baor, Beels, river and Khals), forest (herb, shrub and tree) and settlements including homestead vegetation. Details are presented in Table 3.1.

Post Project

The gross area remaining same and the Net Cultivated Area (NCA) is 14,963 hectare. The rest area are covered with waterbodies (Baor, Beels, river and Khals), forest (herb, shrub and tree), and settlements including homestead vegetation. Details are presented in Table 3.1.

Impact

Net cropped area and water bodies have decreased about 21 and 142 hectare respectively. On the other hand, forest and settlement area have increased about 32 ha and 131 ha respectively. Detailed impacted area is presented in Table 3.1.

Table 3.1: Detailed land use in Kalikota Haor project

Land use	Pre-project Area (ha)	Post-project Area (ha)	Impact (Post-project-Pre-project)
Agriculture	14984	14963	-21
Waterbodies	1073	931	-142
Forest	1377	1409	32
Settlement	365	496	131
Total	17799	17799	0

Sources: Analysis 30 m Resolution Landsat Satellite Images, March: 1989 and 2015

3.2 Land Degradation

No sand carpeting was found before or after implementation of the project.

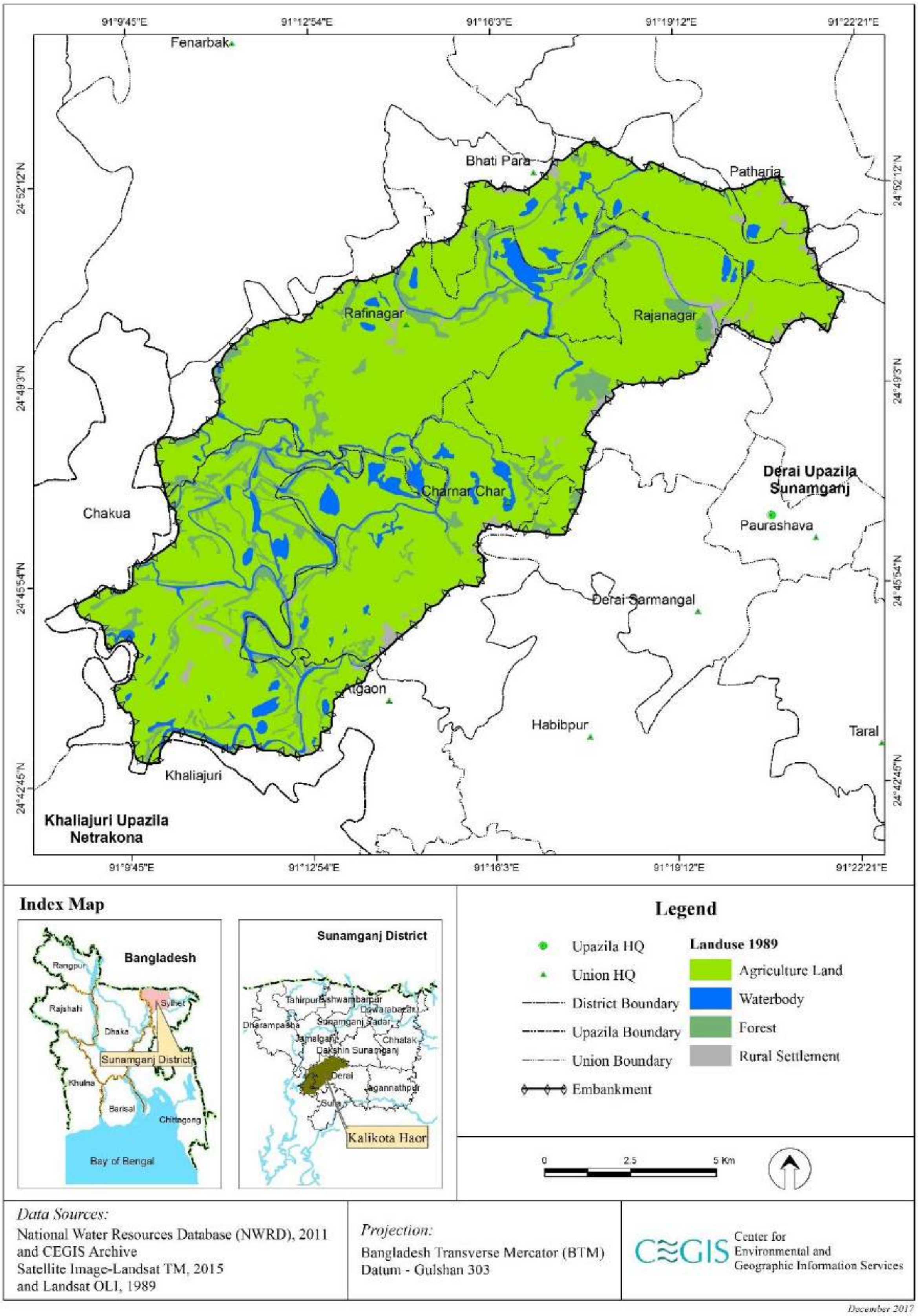

Figure 3.1: Land use of Kalikota haor (1989)

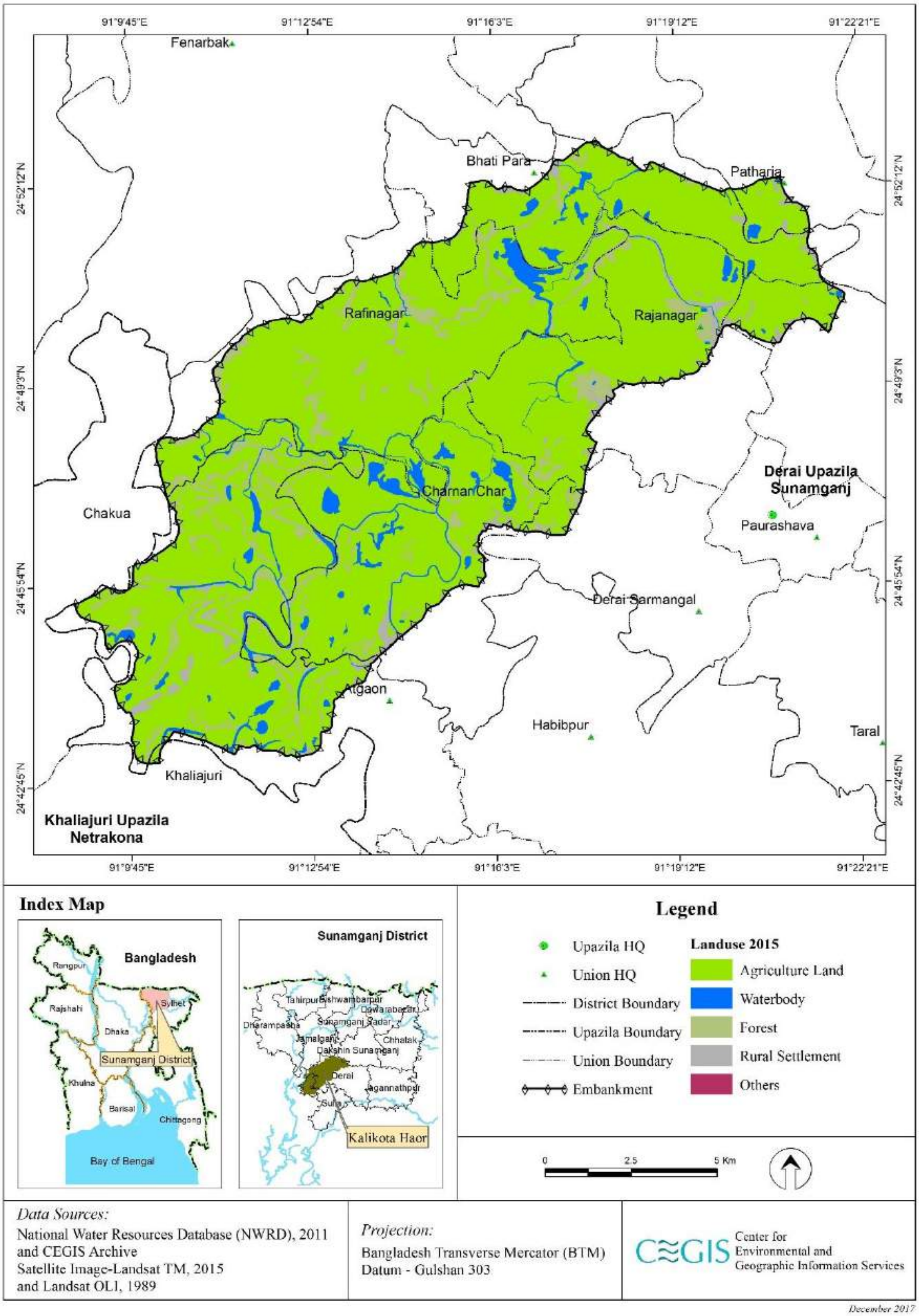

Figure 3.2: Land use of Kalikota haor (2015)

4. Agriculture Resources

Boro rice is the main crop in Haor areas. In most cases, pre-matured or matured Boro crops are damaged by early flash flood which generally happened due to pre-monsoon heavy rainfall in the hilly areas. Besides, drainage congestion and irrigation water scarcity due to siltation of rivers, Khals and Beels are the another problem for Haor agriculture.

Six indicators (cropping intensity, crop area, crop production, crop damage, irrigation and use of agro-chemicals) have been selected for assessing the impact on agriculture resources due to structural interventions in Haor ecosystem. The information of these indicators were collected from both primary and secondary sources. The primary data were gathered from stakeholders through Focus Group Discussion (FGD) and Key Informant Interview (KII). The secondary data were collected from Bangladesh Bureau of Statistics (BBS) and field level Department of Agricultural Extension (DAE) office.

4.1 Cropped Area, Cropping Pattern and Intensity

Pre Project

Before the project interventions, the Net Cultivated Area (NCA) was 14,984 ha where dominant cropping pattern Fallow-Fallow-Local Boro was found. The land type of this project area was dominated by very low land (about 54%) followed by low land and medium low land as presented in Table 4.1

Farmers usually grew local Boro crops in Rabi season. Different varieties of local Boro like Gochi, Boro, Tepi Boro and Shail were very much popular among the farmers. As total cultivable area was single cropped, cropping intensity of this area was 100%. Detailed cropping pattern by land type under pre-project situation is presented in Table 4.1.

Table 4.1: Pre-project cropping pattern on Kalikota Haor

Land type	Kharif-I (March-June)	Kharif-II (July-October)	Rabi (November-February)	Area (ha)	% of NCA
Medium High Land(F_1)	Fallow	Fallow	Local Boro	3	0.02
Medium Low Land(F_2)	Fallow	Fallow	Local Boro	3479	23
Low Land(F_3)	Fallow	Fallow	Local Boro	3452	23
Very Low Land(F_4)	Fallow	Fallow	Local Boro	8050	54
			Total	**14984**	**100**

Sources: CEGIS estimation based on field information, October; 2017

Post Project

The project area became protected from early flash flood due to the project interventions, which influenced farmers to grow high yielding and hybrid varieties instead of local varieties. High yielding and hybrid varieties also produces higher yield than local varieties. Farmers usually prefer the Malatishail, Moynashail, Biroshail and Chengurmuri varieties for LT Aman and BRRI dhan39 for HYV Aman crop in Kharif-II season. For Boro crop, they prefer HYV varieties such as BRRI dhan28, HYV BRRI dhan29 and Hybrid variety such as Hira-2, Janakraj, Sonar bangla and Alok. The cultivated area of local Boro has gradually been decreased and replaced by either HYV or Hybrid Boro. The Net Cropped Area (NCA) has been decreased to 14,963 hectare after interventions.

Dominant cropping pattern of the study area is Fallow-Fallow-HYV Boro covered by 82% of the NCA and rest of the NCA are covered by Fallow-Lt. Aman/HYV Aman-HYV Boro and Fallow-Fallow-Hybrid Boro. Cropping intensity of this area is 108%. Detailed cropping pattern by land type under post-project situation is presented in Table 4.2.

Table 4.2: Post-project cropping pattern on Kalikota Haor

Land type	Kharif-I (March-June)	Kharif-II (July-October)	Rabi (November-February)	Area (ha)	% of NCA
Medium High Land(F_1)	Fallow	HYV Aman	HYV Boro	3	0.02
Medium Low Land(F_2)	Fallow	Lt. Aman	HYV Boro	1,197	8
Medium Low Land(F_2)	Fallow	Fallow	HYV Boro	2,244	15
Low Land(F_3)	Fallow	Fallow	Hybrid Boro	1,496	10
Low Land(F_3)	Fallow	Fallow	HYV Boro	1,945	13
Very Low Land(F_4)	Fallow	Fallow	HYV Boro	8,078	54
			Total	**14,963**	100

Sources: CEGIS estimation based on field information, October; 2017

Figure 4.1: T. Aman crop field in the Janpur mouza

Impact

The Net Cropped Area (NCA) has been decreased to 21 hectare after the interventions. The cultivated area of Local Boro has gradually been replaced by Hybrid Boro/HYV Boro crops due to its higher yield rate and ensure early flash flood protection by project interventions. Impact on cropped area is presented in Table 4.3.

Table 4.3: Impact on cropped area in Kalikota Haor

Crop name	Pre-project Area (ha)	Post-project Area (ha)	Impact Post project- Pre project)
Lt. Aman	-	1,197	1,197
HYV Aman	-	3	3
HYV Boro	-	13,467	13,467
Hybrid Boro	-	1,496	1,496
Local Boro	14,984	-	-14,984
Total	**14,984**	**16,164**	**1,180**

Sources: CEGIS estimation based on field information, October 2017

4.2 Crop Production

Pre Project

Total cultivated area were covered by Local Boro with the yield rate of 3.2 ton/ha in damage free condition. Considering damaged condition, 2.6 ton/ha yield was recorded on an average in Local Boro crops. Thus, the estimated total annual crop production of the project area was about 45,700 tons after loss of 2,248 tons before any interventions. Detailed crop production statistics under pre-project situation is presented in Table 4.4.

Table 4.4: Annual crop production of Kalikota Haor under pre-project situation

Crop name	Total Crop Area(ha)	Damage Free Condition		Damaged Condition		Annual Production (ton)	Production Loss (ton)
		Area (ha)	Yield (ton/ha)	Area (ha)	Yield (ton/ha)		
Local Boro	14,984	11,238	3.2	3,746	2.6	45,700	2,248
Total	**14,984**	**11,238**	**-**	**3,746**	**-**	**45,700**	**2,248**

Source: CEGIS estimation based on field information, October 2017

Post Project

After the implementation of the project, hydrological regime of the study area is changed. Farmers started to cultivate HYV/Hybrid Boro due to presence of submersible embankment and sluice gate which protect the crops from early flash flood. The yield rates of Lt. Aman, HYV Aman, HYV Boro and Hybrid Boro is 2.8 ton/ha, 31 ton/ha, 5.6 ton/ha and 6.8 ton/ha respectively in damage free condition. Hence, total annual crop production is about 76,742 tons with loss of 12,210 tons after interventions. Detailed estimation of crop production under post-project situation is presented in Table 4.5.

Table 4.5: Annual crop production of kalikota Haor under Post-project situation

Crop name	Total crop Area (ha)	Damage free condition		Damaged condition		Annual production (ton)	Production lost (ton)
		Area (ha)	Yield (ton/ha)	Area (ha)	Yield (ton/ha)		
Lt. Aman	1,197	1,017	2.8	180	1.8	3,172	180
HYV Aman	3.0	3.0	3.1	-	-	9	-
HYV Boro	13,467	9,427	5.6	4,040	2.8	64,104	11,312
Hybrid Boro	1,496	1,272	6.8	224	3.6	9,457	718
Total	**16,163**	**11,719**		**4,444**		**76,742**	**12,210**

Source: CEGIS estimation based on field information, October 2017

Impact

Additional 31,042 ton rice is being produced in the post project situation. The rice production is increased due to the protection of flash flood which encourages the farmers for practicing high yielding or hybrid variety instead of local variety. Detailed estimation of impact on crop production is presented in Table 4.6.

Table 4.6: Impact on crop production of Kalikota Haor

Crop Name	Pre-project Production (tons)	Post-project Production (tons)	Impact (Post-project-Pre-project)
Lt. Aman	-	3,172	3,172
HYV Aman	-	9	9
HYV Boro	-	64,104	64,104
Hybrid Boro	-	9,457	9,457
Local Boro	45,700	-	-45,700
Total	**45,700**	**76,742**	**31,042**

Source: CEGIS estimation based on field information, October 2017

4.3 Crop Damage

Pre Project

Flash flood was the main cause of crop damage in pre-project situation. Before harvesting of Boro crop, water entered into the Haor area and damaged the crops. Total crop damage in the project area was 2,248 tons. Detailed estimation of crop damage is presented in Table 4.4.

Post Project

Kalikota Haor is now protected from early flash flood by implementation of project which basically performed well up to 2010. After 2010, flood water enters into the Haor before harvesting of Boro crop (early to mid-March) due to low height of submersible embankment and malfunctioning of structures. Floodwater coming from the upstream through the Mara Gang and Surma Rivers enters the project area through embankment breaches as well as through regulators. The main Khals through which floodwater enters: a) Kalikota Khal, b) Fera-ban Khal, c) Kolkolla-ban Khal, d) Haowar Khal, e) Haira Khal and f) Banda Khal are located at the upstream part of the northwestern area. As this Haor is located relatively downstream in comparison with the Haor in Sunamganj, flash floods enter the Haor in the 1st week of the month April. The main reasons for the flash floods are: a) more rainfall-runoff and inflow from the upstream, b) weak flood protection embankment c) silted up rivers and as a result, fast rising water level.

According to local people, repairing of embankment is done by loose earthen materials of Haor in the month of March, which period is not suitable for embankment repairing. Besides, the flash flood is being carried huge amount sediment and these are being deposited in Rivers, Khals and Beels. Consequently, water carrying as well as retention capacities of surrounding rivers, Khals and Beels are being reduced. For these reasons, crop damage areas are now observed higher compared in pre-project situation. Moreover, plant height of hybrid/HYV is less than local varieties and growing period of most of the Hybrid/HYV varieties are higher than local varieties except BRRI dhan28. So, flood water affects the whole crop area at a time. The annual crop damaged area was 25% due to natural calamities (flash flood and over rainfall etc) but now it is increased to 20%, 30% and 15% in Lt. Aman, HYV Boro and Hybrid Boro due to non-functional condition of submersible embankment and regulators as well as siltation of rivers, Khals, and beels. Most vulnerable mouza's such as Bagmara, Chanar Char, Baragaon, Mirzapur, Paschim Niamatpur, Kamalpur Chak and Sujapur are identified in this respect. Total crop damage is recorded as 12,210 tons in post-project situation. Detailed estimation of crop damage in post-project situation is presented in Table 4.5.

The devastating flash flood inundated the entire Haor area in the first week of March, 2017 and damaged all the standing crops. It caused immense sufferings to the local populace. Some segments of the embankment were breached at that time. At present, the crest level of the embankment of Islampur, Pangaon and Kamalpur was found to be below the design level. As a result, flood water enters the Haor through these areas within 6 to 7 days which is supposed to enter after 9 to 10 days from its occurrences. As a result, flash flood causes crop damage and sufferings to the people every year.

Impact

The crop damage area has been increased from 25% to 30% after interventions, especially after 2010. Therefore, crop damage has been increased to 9,963 tons. This is happened due to the malfunctioning of the interventions and reduced water carrying as well as retention capacity of surrounding rivers, Khals and Beels. Detailed impact assessment on crop damage is presented in Table 4.7.

Table 4.7: Impact on crop damage in Kalikota Haor

Crop Name	Pre-project Production(tons)	Post-project Production(tons)	Impact (Post-project-Pre-project)
Lt. Aman		180	180
HYV Boro	-	11,312	11,312
Hybrid Boro	-	718	718
Local Boro	2,248	-	-2,248
Total	**2,248**	**12,210**	**9,963**

Source: CEGIS estimation based on field information, October 2017

4.4 Irrigation

Pre Project

Before initiation of the project, only surface water was used for irrigating Local Boro crops. The local people normally transplanted this crop immediately after the floodwater recedes and the land is under shallow inundation. Local farmer reported that they stored water with help of bundh/dyke management and irrigated their crop with the help of flooded water in the low lying part of the Haor. They also used traditional modes like *Seuti, Don and Kun* for irrigating their crop from surrounding rivers, Beels and Khals during dry season. Prior to the implementation of the project, irrigation water was more available than the requirement of crops.

Post Project

After implementation of the project, the irrigation water demand has been increased due to cultivation of high water demanding HYV Boro instead of Local Boro crop. On the other hand, the availability of surface water is being reduced due to siltation of surrounding rivers, Khals and Beels of the project area. Besides, the Beels is being dried up by bailing out of water in the month of December-January for harvesting of fish. Therefore, the scarcity of irrigation water has been observed from early February to end of March in most of the year. In this time, Piyain, Mara Gang and Darain rivers are the main source of surface water irrigation. Mainly Low Lift Pumps (LLPs) is being used for lifting surface water instead of traditional mode. T Aman crops is grown under fully rainfed condition.

Impact

There was deficit of irrigation water due to increase of water demand and decrease of water availability during dry season. The irrigation water demand has increased for cultivating high yielding crop variety. On the other hand, surface water irrigation availability has decreased due to siltation of rivers, Khals and Beels of the project area.

4.5 Agro-Chemicals Use

Pre Project

Farmers of the project area cultivated Local Boro in the pre-project situation. The farmers did not apply any chemical fertilizers and pesticides in their local Boro crop. Some farmers used inorganic fertilizers (mixed grass and rice straw) in their crop field for the enhancement of soil fertility.

Post Project

After completion of the project, local Boro variety is replaced by HYV/Hybrid Boro varieties. Generally more agro-chemicals are required for cultivating HYV/Hybrid crops. So, farmers applied more agro-chemicals for HYV Aman, HYV/Hybrid Boro crop cultivation. Per hectare agro-chemicals use by different crops under post-project situation is presented in Table 4.8.

Table 4.8: Use of agro-chemicals under post-project situation

Crop name	Fertilizer (Kg/ha)			Total (kg/ ha)	Pesticides		Total	
	Urea	TSP	MP		Liq. (ml/ha)	Gran. (Kg/ha)	Liq. (Litre/ha)	Gran. (kg/ha)
Lt. Aman	100	-	-	100	-	-	-	-
HYV Aman	120	25	20	165	100	-	0.1	-
HYV Boro	130	40	30	200	200	5	0.2	5
Hybrid Boro	140	50	30	220	250	6	0.25	6

Source: CEGIS estimation based on field information, October 2017

Impact

Use of agro-chemical has increased largely under post-project situation compared to pre-project situation. Additional 630 ton of chemical fertilizers, 3.07 kilo litre liquid and 76 tons granular pesticides are used for HYV/hybrid crop cultivation in this area. Detailed impact on use of agro-chemical is presented in Table 4.9.

Table 4.9: Impact on use of agro-chemicals in Kalikota Haor

Crop name	Pre-project			Post-project			Impact		
	Total Fertilizer (ton)	Pesticides		Total Fertilizer (ton)	Pesticides		Total fertilizer (ton)	Pesticides	
		Liquid (Kilo Litre)	Gran. (kg)		Liquid (Kilo Litre)	Gran. (ton)		Liquid (Kilo Litre)	Gran. (ton)
Lt. Aman	-	-	-	24	-	**-**	24	-	-
HYV Aman	-	-	-	-	-	**-**	-		-
HYV Boro	-	-	-	539	2.69	67.3	539	**2.69**	67.3
Hybrid Boro	-	-	-	67	0.37	8.9	67	0.37	8.9
Total	**-**	**-**	**-**	**630**	**3.07**	**76.2**	**630**	**3.07**	**76.2**

Source: CEGIS estimation based on field information, October 2017

5. Livestock Resources

5.1 Status of Livestock Population, Feed and Diseases

Livestock and poultry, being an essential element of integrated farming system, play an important role in the economy of the Haor area. Livestock provides significant draft power for cultivation, threshing and crushing of oil seeds; cow dung as a source of manure and fuel; a ready source of funds; and meat, milk and eggs for human consumption. A large number of livestock are reared in Haor areas but constrained by flash flood causing inundation of large areas during most of the time in the year. This area is famous for duck rearing due to availability of natural feed for ducks in natural large water bodies. All of livestock species suffer much due to shortage of feed, outbreak of waterborne diseases and inadequate shelter facilities. The livestock rearer in the Haor areas do not get fair price due to poor communication as well as lack of marketing facilities.

The indicator status of livestock has been selected for assessing the impact of the project. The status of livestock population data were collected from Livestock Census (1986), Agriculture census (1996 and 2008) of BBS. The status of livestock feed and fodder, diseases, marketing facilities information were gathered from stakeholders through Focus Group Discussion (FGD) and Key Informant Interview (KII).

Pre Project

According to livestock census 1996, the livestock and poultry population in the project area were 18,510 cattle, 1,560 goats, 34,310 chicken and 32,300 ducks (Table 5.1). Before implementation of the project, the major feed available to ruminants was mostly crop residues (rice straw) supplemented with weeds from cultivated fields. They are to depend on naturally grown grasses in Kandas and alongside roads and embankments. Most of the year before implementation of the project, the crops were to damage by early flash flood. As a result, shortage of feed from crop residues, reduction of grazing facilities seriously affect livestock rearing. That time, the small holders were to depend on water hyacinth and other aquatic plant for their cattle. The major poultry feeds were rice bran, broken rice, kitchen wastes like rice, rice-gruel, vegetables, fish wastes etc. In addition, the duck usually scavenge in the nearby waterbodies like Haor, Beel, Khal, river or any other low lying areas; mainly eat various types of aquatic insects, small fish, shell or snails. Major livestock and poultry diseases were Gola Fula (Haemorragic Septicemia), Foot and Mouth Diseases (FMD), Pox and Cholera, Duck Cholera, Fowl Pox and Fowl Cholera etc. The most vulnerable period was between July to November for spreading diseases to livestock and poultry populations. Mortality rate of the livestock/poultry was higher due to poor shelter condition and they lived in unhygienic condition. Marketing facilities was not in good condition and price was also low due to less demand of their products and by products. Producer consumed their products at family level and additional products were sold at local village market.

Table 5.1: Status of livestock/poultry in Kalikota Haor

Livestock/ Poultry Category	Pre-project		Post-project		Impact
	No of Households having Livestock	Total No of Livestock	No of Households having Livestock	Total No of Livestock	Number of Livestock Population
Cattle	4690	18510	6690	23790	5280
Goat	670	1560	450	1110	-450
Chicken	5930	34310	7050	42440	8130
Duck	4980	32300	3850	24640	-7660

Source: CEGIS estimation based on livestock census (1996), agriculture census (2008) and field information (October 2017)

Figure 5.1: View of Cattle at Janpur mouza

Figure 5.2: View of Duck farm at Sutar gaon mouza

Post Project

According to agriculture census 2008, the livestock and poultry population in the project area are 23,790 cattle, 1,110 goats, 42,440 chicken and 24,640 ducks (Table 5.1). After implementation of the project, crop is protected from early flash flood. As a result, the fodder availability of livestock is increased due to increase of crop production. However, some of the year, the crops were damaged by early flash flood. In that year, the small holders were dependant on water hyacinth and other aquatic plant for their cattle. The poultry feeds are same as in pre project situation. On the other hand, more or less similar diseases are found in post project situation. The mortality rate of the livestock/poultry became negligible during the project period, due to extension works at farmers' level such as immunization and insemination program by Department of Livestock (DLS). Marketing facilities during dry season also improved due to improvement of the communication system by constructing the submersible embankments. Therefore, market prices are increased due to high demand of products and by products.

Impact

From 1996 to 2008, about 5,2800 cattle and 8,130 chicken have increased due to the reduction of flood vulnerability, improvement of marketing facilities and strengthening of livestock extension services. On the other hand, the goat and duck population has been decreased to 450 and 7,660 respectively. Details about impact on livestock are presented in Table 5.1.

6. Fisheries Resources

Kalikota Haor system is bounded by four-river system (mentioned in Water Resource Section) which act as the major water sources for maintaining sustainability of fish habitat. This Haor is surrounded by a number of Haors: a) Shanir Haor and Khai Haor in the north, b) Pagner Haor, and Khaliajur FCD Polder-1 in the west, c) Khaliajuri FCD Polder-2 in the south, and d) Udgal Haor in the east. The Kalikota Haor is fed by a number of connecting Khals of which important ones are Madhupurer Khal, Gonker Khal, Islampur Khal, Kuchirgaon Khal, keogaon Khal, katagang Khal, Mirjapurer Khal, Gachgora Khal, Chubchonai Khal, Sharmar Khal, Alipur Khal, Kertikpur Khal, Banerchar Khal, Janpur Khal, Anentopur Khal, Jotir Khal, Gochia Khal, Mokshidpur Khal, Dadpur Khal etc. Moreover, there is a Baor in the Haor which is known as Mora Gang (Mora Surma River). The Haor possesses a large number of Beels of which major ones (sizes vary from 4 to 25 ha) are Chatal Beel, Adir Beel, Char Kaman Beel, Kalikota Beel, Piyan Beel, Ainal Beel, Khali Beel, Gatua Beel, Dhuli Beel, Banda Beel, Jaladi Beel, Chata Beel etc. According to local people, Banda Beel, Kalikota Beel, Jaladi Beel, Ainal Beel, Dhuli Beel are the main fish breeding grounds of this Haor system. The field investigation revealed that the water centric interventions significantly control the hydrodynamic condition for fisheries resources of this Haor System.

6.1 Habitat Area

Pre Project

Fish habitat has been assessed from the land use data that is extracted from the satellite image of 1989. The estimated total area of fish habitat of the Haor was about 16,057 ha where capture fishery was the sole contributor. There were some pits/ponds having no dike inundated naturally and some ponds with high dike. The ponds without dike are considered under floodplain habitat whereas the ponds with high dike had aquaculture activities. There was a Baor (Oxbow lake), given lease and functioned as a culture fishery. Floodplain shares the major part (about 93%) in the total habitat area followed by Beel, Khal, Baor and fish pond. The breakdown of functionally different fish habitats of this Haor is given in Table 6.1.

Post Project

Similarly, the estimated fish habitat area has been assessed from the land use data, which extracted from image of 2015, is about 15,879 ha. The increment of fish habitat area by about 237 ha, which is contributed by, newly created borrow pit area of about 175 ha, fish pond area of about 11 ha and Baor of about 51 ha. On the other hand, the decrement of fish habitat area by about 415 ha, which is contributed by the loss of Khal area of about 292 ha and Beel area of about 102 ha and floodplain of about 21 ha. The habitat area loss offsets the habitat area gain and thus the resultant net loss of habitat area is about 178 ha. The loss of habitat occurs may be due to siltation of Khal bed and associated decrease of river conveyance, Beel bed aggravation by loose top soil from agriculture field with run-off water and embankment breached soil, etc. The borrow pit is created for the construction of submersible embankment and cross-road. The breakdown of functionally different fish habitats of this Haor and habitat changes is given in Table 6.1.

Table 6.1: Breakdown of fish habitat area by habitat type

Sl. No.	Habitat Category	Habitat Type	Area (Ha)		Impact (Ha) (Habitat Area Change)
			Pre-Project, 1989	Post-Project, 2015	
1	Capture Fishery	Khal	391	99	-292
2		Perennial Beel	634	532	-102
3		Floodplain	14,984	14,963	-21
4		Borrow Pit	-	175	+175
		Sub-Total =	**16,009**	**15,769**	**-240**
5	Culture Fishery	Fish Pond	-	11	+11
6		Baor	48	99	+51
		Sub-Total =	**-**	**110**	**+62**
		Grand Total=	**16,057**	**15,879**	**-178**

Source: Fish habitat assessment based on field findings and image based landuse data,1989 & 2015.

Impact

The net loss of fish habitat area in the post-project condition is about 178 ha, which is negligible (about 1 %) in compared to Pre-project condition.

6.2 Habitat Condition

Pre Project

Floodplain was unregulated; timely entry of water into the Haor; silt carried by the rivers was dispersed over the Haor uniformly; river conveyance capacity was more. Local people opined that the Beels retained water in the dry season at a depth suitable for fishery. Among the Banda Beel, Kalikota Beel, Jaladi Beel, Ainal Beel, Dhuli Beel Beel had average depths ranges from about 2.5-3.5 m during dry season. Some of the Beels, such as Chatal Beel, Char Kaman Beel, Kalikota Beel, Piyan Beel, Khali Beel, Gatua Beel, Chata Beel etc. were shallow and dried up by bailing out of water in the month of December-January for harvesting fish. There were some Beels with leasing system and the lessee control the Khal mouth to hold water for fish production during recession period and to inhibit water entry into the Haor to protect Boro paddy during the onset of monsoon.

Little better ecosystem was maintained with the exchange of pre-monsoon nutrients between river and Haor; new water breeding stimulation to the small indigenous species (SIS) of fish; higher breeding success; less natural and fishing mortality; rich biodiversity; more sustainable fish production, etc.

Post Project

Floodplain is regulated; floodwater enters into the Haor in the late pre-monsoon; silt deposited on the river bed as dispersion of silt is hindered or restricted by the submergible embankment; decreased river conveyance capacity. Local people opined that some of the Beels retained water in the dry season at a depth less suitable for fishery. Among the Banda Beel, Kalikota Beel, Jaladi Beel, Ainal Beel, Dhuli Beel average depths ranges from about 1.5-2.5 m during dry season. This is happened may be due to wash out of loose soil of agriculture land and breached embankment along with river borne sediment. Some of the Beels, such as Chatal Beel, Char Kaman Beel, Kalikota Beel, Piyan Beel, Khali Beel, Gatua Beel, Chata Beel are shallow and dry up by bailing out of water in the month of December-January for harvesting fish.

Ecosystem is being degraded gradually but lightly as some of the water control structures are not functioning properly. Exchange of pre-monsoon nutrients between river and Haor is being hindered or restricted to some extent by the submergible embankment; delayed new water entrance into the Haor and hampering breeding stimulation to the small indigenous species (SIS) of fish; in some cases egg deposited in the fish body; lower breeding success; little higher natural and fishing mortality; slightly declining trend in fish biodiversity; less sustainable fish production, etc.

Impact

The net physical condition of habitat is negligibly degraded and corresponding provisioning services of the ecosystem including fish. However, the changes in habitat suitability condition of rivers, Khals and Beels in terms of quality occurred more due to unconventional Beel fishery, illegal fishing (use of chemical fertilizer), extensive use of agrochemicals and pesticides in paddy field, etc. rather than water centric interventions.

6.3 Fish Diversity

Pre Project

This Haor was rich in fish biodiversity containing about 110 species (Table-A1 of Annex-A) in the pre-project condition as some of the Beels are perennial and retained water at higher depths mentioned above suitable for fishery. The fish diversity particularly SIS was also facilitated by the unregulated lateral migration from river to Beel and Beel to river during pre-monsoon breeding season. Thus Beel resident fishes (particularly 'SIS' of fish) were dominant in the Beels and floodplain. Moreover, the abundance of large-sized adult fish species (Rui- *Labeo rohita*, Catla- *Catla catla*, Ghonia- *L. gonius*, Boal- *Wallago attu, Ayre- Mystus aor,* Chital- *Notopterus chitala,* Shol- *Channa striatus,* Pabda- *Ompok pabda,* Boro Baim- *Macrognathus aculeatus,* Shar Punti- *Puntius sarana, Nanid- Labeo nandina etc.)* were also more. Furthermore, species were evenly distributed in the whole Haor system.

Post Project

Fish species diversity has the declining trend but in slow pace in the Post-project condition. This is happening may be due to many factors other than water control structures. The factors include habitat loss (both depth and area), water pollution, water regulatory structures, unplanned fisheries management, over exploitation of fish due to increase of fishers and modernization of fishing technology, indiscriminate fishing e.g. use of harmful fishing appliances, catching of post larvae and brood fish, complete dewatering of leased water bodies (less than 5 acres) for fishing, etc. In consequence of the above phenomena, following fish species become locally unavailable (for last 5-10 years) or have become rare includes Boro Baim, Shar Puti, Chital, Pabda, Boro Chingri (*Macrobrachium rosenbergii*), Nanid (*Labeo nandina*), Rui, etc.

Impact

Comparing Pre-project and Post-project conditions, it can be concluded that changes in fish species diversity and composition are not comprehensible in response to Project intervention. Whatever changes in species diversity and composition between two phases are observed may be posed due to other anthropogenic factors mentioned above.

6.4 Fish Migration

Pre Project

Previously, the Haor was hydrologically linked with the Udgal Haor and Pagner Haor. For this reason, the abundance of large fishes like Rui, Catla, Ayer, Chital, etc. were more. Local fishers stated that the lateral fish migration was open through the natural connectivity during pre-monsoon. Furthermore, most of the fries of riverine fishes enter the Beels and floodplain along with flood water. However, successful lateral migration of different fishes e.g. riverine carps, catfishes, etc. at their certain stages of lifecycle for food and residence is happening due to sufficient depths of the Beels.

Post Project

Pre-monsoon (15 April – 15 May) spawning/breeding migration of riverine and Beel residence SIS fishes is mostly impeded through different connecting Khals due to water regulatory structures. Besides, riverine fishes migrate laterally to the Beels by overtopping or breaching of the existing embankment of the Haor during flooding months of Jaisthya-Ashar (15 May–30June).

Pre-monsoon (15 April – 15 May) spawning/breeding migration of riverine (mainly the Surma and Piyain rivers) and Beel residence fishes through different connecting Khal is due to construction of closure, water regulatory structures. Besides, riverine fishes migrate laterally to the Beels by overtopping or through breaching points of the existing embankment during flooding months of Jaisthya-Ashar (15 May–30 June).

Impact

Comparing Pre-project and Post-project conditions, it can be concluded that migration of SIS is impeded during the pre-monsoon in Post-project condition and comprehensible impact has not been observed on fish migration in response to submergible embankment.

6.5 Fish Production Assessment

Pre Project

The estimated total fish production was 3,455 metric ton (MT) in 1,989 where floodplain shared the most about 75% followed by Beel, Khal, Baor and fish pond as presented in (Table 6.2).

Post Project

The estimated total fish production is about 6,266 metric ton (MT) in 2015 where floodplain shared the most about 83% followed by Beel, Borrow pit and River & Khal as presented in (Table 6.2). In the production assessment, the productivity of the corresponding year has been used.

Impact

Net increase in fish production in Post-project condition is about 4,681 metric ton. As a whole, fish production has been increased by about 295%, whereas the floodplain production by about 337% and Beel by about 102% (Table 6.2). Such huge increment in productivity may be caused due to adoption of fisheries management like Beel fishery, Beel nursery, increasing fishing activities, fishing commercialization, stocking of culture fish species in Beel fishery, etc. Moreover, the newly created habitats like borrow pit, fish pond and Baor have added 263, 28 and 119 metric ton of fish respectively. The breakdown of fish productions is presented in the following Table 6.2 by functional unit of fish habitats.

Table 6.2: Breakdown of fish production by functional habitat

Sl. No.	Habitat Category	Habitat Type	Production (MT)		Impact (MT) (Production Change)
			Pre-Project, 1989	Post-Project, 2015	
1	Capture Fishery	Khal	90	33	-57
2		Perennial Beel	284	575	+291
3		Floodplain	1,199	5,238	+4,039
4		Borrow Pit	-	263	+263
		Sub-Total =	**1,573**	**6,109**	**+4,535**
5	Culture Fishery	Fish Pond	-	28	+28
6		Baor	12	131	+119
		Sub-Total =	**-**	**159**	**+147**
		Grand Total=	**1,584**	**6,266**	**+4,681**

Source: Fish production assessment based on field findings and FRSS data, 1989 & 2015.

6.6 Fishing Appliances

Pre Project

Different types of fishing appliances are used to catch fishes. The mostly used fishing appliances are: gill net, Ghurni jal/Ber jal, push net, Khoira jal, hook, Gui (one type of trap used to catch small fishes), Sip etc. Furthermore, illegal fishing practice was reported in the leased Beel. Dried up the whole Beel for harvesting benthic fish species may be considered as a good example of illegal fishing. However, this type of fishing depends on the leasing rotation system.

Post Project

Leaseholders (LHs) generally use Katha as Fish Aggregating Device (FAD) for fish. LHs usually harvest fish annually. However, another type of fishing pressure has been increased day by day around the water control structures. The local fishers (particularly part-time fishers) create barrier at the mouth of water control structures by net for catching fish. This fishing pressure becomes more prominent during recession of floodplain water in the post-monsoon season.

Impact

The project is almost fully functional and possesses water control structures. For this reason, some deviation in fishing activities is found in response to Project intervention. Fishing is done at each of the water control structures which were absent in thepre-project condition. On the other hand, fishing pressure is also increased with the increasing of fish demand and fish supply chain for both the national and global fish market.

6.7 Fishers Livelihood

Pre Project

Field findings reveal that about 30% of the Haor population were engaged in fishing and activities involved in fish supply chain for carrying out their livelihoods. Out of which about 5%

were commercial fishers and the rest of them were subsistence level fishers. Commercial fishers spent annually about 190 days (8-10 hrs/day) in fishing.

Post Project

Presently, about 80% of Haor population are engaged in fishing activities. The number of fishers are increasing day by day due to demand of Haor fishes as well as increasing of market price. It may be mentioned here that about 80% house hold of Atgaon union and Charnar Char of Kalikota are involved in fishing and trading. Because land area of this union is comparatively low and most of the perennial Beels are located here. The fisheries number Commercial and subsistence level fishers spend annually about 290 days (12-15 hrs/day) and 180 days (5-7) hrs/day) respectively in fishing. They mainly catch fish in the open water area in and around the Haor for carrying out their livelihoods. Furthermore, a number of part-time fisher groups are evolved and increased day by day for fishing at the mouth of the connecting Khals where there are water control structures.

Impact

It can be concluded that the number of part-time and subsistence fishers are increased in response to the Project interventions.

6.8 Fisheries Management

Pre Project

Beel fisheries with leasing system were the prominent fisheries management as reported from the local people. All Beels were harvested in the months of February and March. Beel fishery was more sustainable. However, there was no community based fisheries management in this Haor.

Post Project

Beel fisheries with leasing system are also the prominent fisheries management in the With Intervention condition. All leased Beels are harvested annually. Seasonal Beel is used to dry up for catching benthic fish species. However, this type of fishing depends on the leasing rotation system of the Government. Beel fishery is becoming less sustainable. There is a number of fisheries associations is a community based fisheries management in this Haor. There is no enforcement for limiting or controlling indiscriminate fishing at the water control structures. Every year department of fisheries deploy mobile court from Jaisthya-Ashar (May to June) to conserve fries in the Haor area. During this period, fish caching through using of any sort of mesh size net in the Haor area is totally prohibited.

Impact

Rotation length of time for fishing in most of the leased Beels is decreased from three-year rotation to one-year rotation in the with post-project condition. Such over exploitation in conjunction with indiscriminate fishing at the water control structures is being happened mostly due to earn more money and driving fishery ecosystem into fragile resources.

7. Ecosystem

The Haor Basin in the north eastern part of Bangladesh is a wetland ecosystem considered to be of international ecological importance due to the extensive waterfowl population that uses the basin as its habitat and for other natural resources. Kalikota Haor is one of them and its area covered four upazilas namely Sulla, Dirai, Khaliajuri and Dakshin Sunamganj. It occupies terrestrial as well as aquatic ecosystems. Local biodiversity and their species density and population vary in different parts of this project area according to land levels and land use. Major ecosystems observed in the project area are homesteads, canal, Baor, Beels, ditches, seasonal wetlands etc. A diversified fauna group along with aquatic species also occurs in this Haor ecosystem. Overall changes of ecosystem pattern and their diversity, coverage, habitat condition are described below.

7.1 Terrestrial Flora

Pre Project

Before intervention taken place, study area was comprised of different terrestrial species and the diversity were observed mostly in upland portion as well as homesteads, ridge, institutions, roads, crops field etc. Most of the households were vegetated by local cultivated plants and a small portion of the coverage was occupied by wild shrubs and herbs. According to the senior sample respondents, common cultivated plants were Silkoroi (*Albizia procera*), Kathal (*Artocarpus heterophyllus*), Aam (*Mangifera indica*), Narikel (*Cocos nucifera*), Mahogoni (*Swietenia mahagoni*), Raintree (*Samanea saman*), Baroi (*Zizyphus mauritiana*), Shimul (*Bombex ceiba*), Jum (*Syzygium cumini*) etc. Raintree, Narikel, Silkoroi occupied the top canopy. Other trees, shrubs and herbs occupy lower canopies like as patipata, dolkolmi, makhna, jagotmadan, bonjal were common of all. Almost all tree species except wetland trees present on homestead platforms were sensitive to flood water. Homestead vegetation at the southern portion of Baragaon, Paschim Niamatpur, Daudpur, Bagmara, Sarifpur etc. villages were under threats due to wave action in monsoon. Except cultivated varieties, major weed species growing with the crop in this area are *Euphorbia hirta, Rorippa indica, Cynodon dactylon, Marsilea quadrifolia, Heliotropium indicum, Cyperus sp*, *Croton bonplandianum, Chenopodium sp,* etc. Different types of marginal trees like Panimorich, Biiskatali, Nol, Khagra etc. were dominant in inner portion of the canal whereas bermuda grass, cyperus, cogon grass, justiceae and various types of grasses were found on upper portion of the canal dykes. Major species were cultivated along the road side of project area were Sirish, Sisso, Pitali, Jarul, Mahogoni, Sil koroi etc.

Post Project

At the present scenario, settlement area and new settlement (Locally called Noyahati) have been rapidly expanded throughout the project area especially in the northern to eastern portion of the Kalikota Haor According to local people, submersible embankment is working as a safeguard and protects internal vegetation from wave action in monsoon period, consequently terrestrial vegetation coverage and their density have enriched in homestead platforms comparing the pre intervention period.. But planted tree species are mostly exotic timber yielding species e.g. Akashmoni (*Acacia moniliformis*), Sisso (*Dalbergia sissoo*), Manjium (*Acacia mangium*) etc. During field survey it was evident that, almost similar type of timber yielding trees exists all over the project area. Upland vegetation inside the project area has been mostly cultivated of timber and fruit yielding varieties. Cropfield ecosystem consist least diversity of floral communities and provides wide area of grazing and feeding habitats for different wildlife.

Impact

On the basis of perceptions gathered from the sample respondent and from field observation, the change in the terrestrial flora has no significant effect from the interventions. Changes of vegetation pattern have turned natural to secondary plantation form. The net settlement and crop field vegetation area has been increased in mainly north and east portion of the Kalikota Haor. Overall terrestrial floral diversity and coverage have been changed but insignificant. Indicator species and their ecological status are presented below (Table 7.1):

Figure 7.1: Terrestrial floral composition inside the Kalikota Haor area

Table 7.1: Changes of status of the terrestrial flora

Indicator	Location	Pre project	Post project	Cause of status change	Type of Intervention that caused the change (Yes/No)
Exotic species	Settlements, Roads, Ridge	density was low	Moderately dense	Increased through plantation program	No
Native species	Settlements, Cropfield	Moderate	Low	Agricultural expansion, Exotic tree species plantation	No
Agricultural weeds	Crop field	Low	Moderate	Changes in cultivation pattern	No

7.2 Terrestrial Fauna

Pre Project

Diversity of terrestrial fauna is one of the most important ecological indicators to evaluate the quality of habitats. Before intervention period, nnatural habitat with many jungles and bushy lands were common in upland (Kandas) and medium low land areas of this haor. This land was contented habitat for native and migratory birds, mammals, reptiles, amphibians and other wild animals. Among the terrestrial mammals, common mammalian species in the project area was fishing cat (Falis viverrina), Jungle cat (Falis chaus), Bengal fox (Vulp bengalensis), Common mongoose (Herpestes edwardsi), Common House rat (Rattus rattus), Shrew (Suncus murinus) etc. The population of snake was healthy as they have better shelter in this vast open landscape. Common bird of prey species was found in the project area were Black Drongo (Dicrurus macrocercus), Crested Serpent Eagle (Spilornis cheela), Brahminy Kite (Heliastur indus), Brown Fish Owl (Ketupa zeylonensis), Common Myna (Acridotheres tristis), Asian Pied Starling (Sturnus contra), Red Vented Bulbul (Pycnonotuscafer), Oriental Magpie Robin Copsychus saularis), Spotted Dove (Streptopelia chinensis), Blue Rock Pigeon (Columba livia), Asian Koel (Eudynamys scolopacea), Coppersmith Barbet (Megalaima haemacephala), Jungle Babbler, Black Hooded oriole (Oriolus xanthornus), Common Hoopoe (Upupa epops). These were found to be more common as they always try to live near human settlements of the Haor area.

Post Project

Species richness of terrestrial local avifauna has been concentrated in settlements and birds occupy higher number of species than other classes. At this time, habitats of birds, mammals, amphibians and reptiles inside the project area have been gradually being reduced due to various reasons including depletion of natural vegetation, agricultural expansion, change in natural vegetation pattern, use of pesticides and insecticides, plantation of exotic trees and other several anthropogenic activities. So, some native birds (e.g. Mayna, Dove, Starling, Bulbul, Drongo etc.), small mammals (e.g. jackal, mongoose, shrew) have been successfully adapted and expected to increase in this situation due to change of vegetation coverage and agricultural expansion. Exotic large trees have been good shelter for raptor bird. Population of snakes, lizards, skinks has been lowered in number due to hunting and killing by local people and depletion of natural habitat area. Population of migratory birds has been rich in eastern part than the other part of haor area. In the eastern side of this haor, tree plantation program is becoming popular among the locals especially swamp trees (such as Koroch, Hizal and Pitali) which is providing different ecosystem services.

Impact

Intervention has not any strong relation with the change of the status of terrestrial fauna rather the changes occurred naturally over time. For different anthropogenic activities like agricultural expansion, planting exotic and swamp trees and other human interference is responsible for the changes. Thus, intervention is has no direct impact in this regard.

7.3 Aquatic Flora

Pre Project

Compositions of aquatic floral species vary according to wetland depth and duration of inundation in the haor area. Before intervention taken place, following types of vegetation found in aquatic habitat were submerged, free floating, rooted floating, Sedges and meadows plants. Numerous canals, beels were abounded with free floating and rooted floating hydrophytes. Submerged plants were prevalent in the project area, both in perennial and seasonal wetlands. These plants start growing with the rise of water level and persist as long as water is present. *Hydrilla verticillata* were most common in this vegetation type. Free floating plants were also common throughout the project area. *Eichhornia crassipes* and *Jussia repens* was the most dominant species followed by *Salvinia, Azolla, Pistia* and *Lemna*. Rooted floating plants make one of the most dominant plant types in the project wetland areas. At the species level *Nymphaea nouchali*, *Nymphaea stellata* etc. were the most common aquatic flora. However their abundance was only in perennial and deeply flooded seasonal wetland. Sedges and meadows formed an ecotone type consisting of amphibian plants. This type has the highest species diversity and iwas one of the most important wetland plant communities in the project area. At the species level *Enhydra fluctuans*, *Ipomoea aquatica* and *Ipomoea fistulosa* were common in seasonal wetlands.

Post Project

After the intervention, the floral diversity lessened for different anthropogenic activities. Present use of pesticides and fishing methods causing harming towards the aquatic flora. Over extraction of floating, rooted or deeply rooted plants; causing threat for the diversity of this floral community. Major free floating plants found within the study area are: *Azolla pinnata, Eichhornia crassipes, Lemna perpusilla, Pistia stratiotes, and Salvinia cucullata.* A number of submerged and attached floating plants exist in this haor but lower in number considering the pre-intervention period according to the sample respondents.

Impact

There is no direct impact of intervention work on aquatic floral species rather different anthropogenic factors like agricultural extension, uses of chemical fertilizer, over extraction of economic plants (Shapla, Padma, Singara etc.) reducing the diversity and population. Deterioration and squeeze of aquatic habitat and their floral diversity area has been gradually removed at kalikota haor area over time. Thus intervention is not responsible in this regard.

Figure 7.2: Aquatic floral diversity in the project area

7.4 Aquatic Fauna

Pre Project

The hydrological cycle and the presence of perennial and seasonal wetland provide a diversified habitat for all biota inside the haor area. In the dry period, most of the wetlands except beels in these areas remained completely or partially dry. Among amphibians, Common Toad (*Duttaphrynus melanostictus*), Skipper frog (*Euphlyctis cyanophlyctis*), Cricket Frog (*Fejervarya* Sp.) were common and found in most wetland habitat (e.g. ponds, canals and ditches) and has been the most successful in adapting to the habitat. Common Smooth Water Snake, Checkered Keelback, Common Skink, was found pretty common. Common wetlands bird species those were available in the project area namely Indian Pond Heron, Little Egret, Common Kingfisher, Little Cormorant, Common moorhen etc. Migratory birds were quite common in haor area. This bird were generally take temporary shelters and flock in reed land and numerous beel areas, paddy fields, water bodies, rivers, marshy lands and even in the local ponds. Common migratory bird species in the project area were Chhota

Sarali, Bara Sarali, Nilshir, Balihansh, Bhulihansh, Snake bird, Pintail Duck, Chokha-chokhi etc.

Post Project

It was clear after field visit that, considering the before project scenario the number and diversity of aquatic fauna has decreased over time. The mammals, birds, amphibians and reptiles population gradually dropped for different factors. The life cycle of the aquatic or wetland related fauna has been dependent on the beel ecosystems natural fluctuations and isolation and connection with river and other nearby wetlands. As per the sample respondents, now migratory bird species are visiting only few beels namely in Jaladi beel, Adir belel, Ainal beel, dhuli beel of the total haor area and the resident aquatic birds are not seen often like before. Current status of bullfrog, turtle decreases over time due to hunting and death from fishing nets. Turtles are rare and threats in area due to degradation of wetland ecosystems.

Impact

Variation of wetlands and its characters support habitats for various aquatic fauna. Over the time for different anthropogenic causes the number of aquatic fauna reduced remarkably but it is evident that there is no direct connection for such loss with the intervention activities. Habitat condition and their diversity have been remarkably changed at northern portion due to several anthropogenic activities. Faunal habitat condition is still favorable at mid and eastern portion of the haor than the other areas.

7.5 Swamp Forest and Reed Land

Pre Project

In the previous scenario, there was no swamp forest in the Kalikota Haor area, but presence of wetland tree such as Karoch (*Pongamia pinnala*), Pitali (*Trewia nudiflora*), Baroon (*Crataeva nurvala*), Hizol (*Pongamia pinnata*), Bhuri (*Trewia nudiflora*) etc. were found at agricultural land, settlement ridge, along the road side, canal dykes, inside the baor and beel area. Reedland vegetation was mostly observed in eastern portion of the haor area. Major species were Nol (*Phragmites karka*), Ikor (*Sclerostachya*), Khagra (*Xanthium indicum*), Bet (*Calamus tenuis*) Binna (*Vetiveria spp.*), Chan (*Imperata cylindrical*), Patipata (*Schumanianthus dichotoma*), Kakdumur (*Ficus hispida*) etc. Among the tall grasses were also quite common all over at the canal dukes and settlement ridge, grazing land inside the Kalikota Haor area.

Post Project

Reeds coverage area has been reduced due to wetland degradation, land converted to crop field, over harvesting of economic plants and other several anthropogenic activities. But still major species are Nol (*Phragmites karka*), Ikor (*Sclerostachya*), Khagra (*Xanthium indicum*), Bet (*Calamus tenuis*) Binna (*Vetiveria spp.*), Chan (*Imperata cylindrical*), Patipata (*Schumanianthus dichotoma*), Kakdumur (*Ficus hispida*) etc.

Impact

Reed land vegetation is now under threats throughout the project area. So their coverage and density are low except southern portion within the project area. Interventions are not responsible in this regards.

7.6 Ecosystem Goods and Services

Pre Project

Homestead and cropland vegetation have a major contribution for meeting food, fodder, medicine, fuel and other household requirements to the local people. Homestead vegetation has also major a contribution for timber and fuel wood supply. Utilization of wetland plant products was high in the project area before intervention taken place. The wetland plant products and services include: animal foods (Kachuripana, Khar etc.), other foods (use as vegetables), fodder and forage, fuel (Dolkolmi), medicine and thatching (Binna grass, Chan). Fishes were the staple protein provider of the local people that comes from wetlands like haor, beels, khals and homesteads ponds.

Post Project

Ecosystem goods and services are diversified within the Kalikota Haor area. Utilization of wetland plant products has been reduced day by day over time. Binna grass is now low density in project area because of over harvesting for household purpose. Medicinal plants have been destroyed due to over extraction and agricultural expansion throughout the area. Every year new succession of herbs and shrubs on settlement ridge has been increased overall vegetation coverage that supports feeding and grazing habitats of many fauna like bee-eater, flycatcher, skink, frogs etc

Impact

Degradation of the conditions of swamp forest and reed beds has lead to several impacts on resource use and livelihood of the local people. Swamp forest and reeds bed used to act as a good shelter and feeding ground for aquatic faunas, birds including fish. Thus degrading swamp forests for anthropogenic causes leading indirect effect on fish dependant bird and other wildlife resulting food crisis. Intervention may suspect to the siltation in the Haor area but has no direct relation with the effect of swamp forest and reed land regeneration. Conversion of reedland for agricultural expansion is only considered indirect impact regarding this issue.

8. Socio-economic Conditions

8.1 Introduction

The Haor system provides a wide range of economic and non-economic benefits to the local people as well as other people of Bangladesh. This is (Haor) an important source of agriculture, commercial fishing, cattle and buffalo rearing, duck rearing, collection of reeds and grasses, collection of aquatic and other plants. This study was conducted at Kalikota Haor under the Derai and Sullah upazila of Sunamganj district. The socio–economic scenario was explored in this section to understand both before and after project people’s condition using both primary and secondary data in relation to the objectives of the study.

8.2 Location and Population

This study is conducted at the Kalikota haor region which is located at the Derai and Sullah upazila under the Sunamganj district in Sylhet division. In Derai upazilla, there are forty five mouzas (45) under the Rajanagar, Charnar Char and Bhati Para unions and eleven (11) mouzas under the Atgaon union in Sullah upazila. Following table 0.00 shows the union wise population of this study area based on Bangladesh population and housing census 1991, 2011 and projected population in 2017.

The Population and housing census data 1991 shows the number of population during the intervention. The population and housing census data 2011 and projected population data in 2017 depicted the change in population in the study area during the period.

Table 8.1: Union wise population of the study area

District Name	Upazila Name	Union Name	Total Population in 1991	Total Population in 2011	Projected Population in 2017
Sunamganj	Derai	Bhati Para Union	15394	51604	110862
		Charnar Char Union	19470	26049	
		Rajanagar Union	19734	19320	
	Sullah	Atgaon Union	26057		
Total Population			80655	102171	

Source: Bangladesh Population and Housing Census 1991 & 2011

8.3 Livelihood Status

Pre Project

Agriculture was the prime source of livelihood for the majority of population. Production of crops yielded them their food and cash money. The livestock, forestry and fisheries were the secondary sources of income. In addition, other sources of income were non- agricultural labor, business and employment.

Post Project

The primary livelihood (agriculture) remaining almost the same as before, its environment has improved with higher yields and less damage to crops. The second major livelihood (fishing) has experienced twofold impacts: (i) open fishing opportunity has been restricted due to less movement of fish into embanked area even after submergence and (ii) the poor part time or full time fishers who used to fish before project feel psychologically restricted to fish in embanked area due to a spell of project control. Besides these, livelihood opportunity for wage labour has increased in agriculture. Overfishing from the haor and siltation of riverbeds have recently caused reduction of fish resource, thereby causing loss of livelihood opportunity for the poor. Kalikota haor, its water body, by and large, has still remained the major source of livelihoods for the people of the locality.

Impact

Agriculture is the main sources of income so far and the agricultural production is increasing in Kalikota haor area. Income opportunity based on fishing has declined and only some people from fishing community got access only to do work as a seasonal labor in this particular area. Due to leasing arrangements, which are often controlled by local elites, result in highly restricted access to open water fisheries by the poor.

8.4 Accessibility in Education and Health

Pre Project

Before intervention, the health and education for the people of Kalikota haor region were not accessible to all. During the rainy season, primary education is frequently disrupted during floods almost every year. People used to use boat to go both schools and health institution while walking was the main means to go at the remote schools and health institutions. Some partial infrastructural damage often happens. Schools remain closed for 70 days in average every year due to flooding as well as the school buildings are used as shelter for the flood affected people. On the other hand, students living in distance area usually drop their classes due to unsafe communication during monsoon. On the other hand, the flood induced poverty increases the number of drop-out students in this haor. Nevertheless, proper flood protection may improve children's schooling opportunities and increase the overall literacy as well.

Post Project

After intervention, the health and educational institutions have increased with time and people, especially school going children, have become enthusiastic to go to schools run under different Govt. and NGOs programs. Besides, when the submergible embankments were constructed, local people, school going children, pedestrian, women and other people have been using it as road especially in the dry season. Presently, when some of the locations of the embankments are damaged, people's way to reach to the schools and health institutions are reported to be hampered for a certain period. But in wet season, deferent types of boats are the main sources of transportation for going to school and health center.

Impact

With the period of time, the health and educational institutions have increased and people especially school going children have become encouraged to go to schools run through different Govt. and NGOs programs. Besides, with the establishment of embankments local people, school going children, pedestrian, women and other people got the way easy by the use of this embankment's alignment (*Ayle*) especially in the dry season. Presently, when some of the locations of the embankments are damaged, people's way to reach to the schools and health institutions get hampered for which people of Kalikota haor suffer mostly for a certain period of time being.

8.5 Land Price

Pre Project

Before intervention, the land price of this haor region was minimal and people were not interested to buy land due to regular flash flood and crop damage. It is reported by local people that the price of agricultural land was BDT 6000 to BDT 7000 per Keyar[1] and BDT 10,000 to BDT 12,000 for homestead land before project. With the project-induced change and autonomous development in the whole haor region this situation has changed and the land price has increased with the period of time.

Post Project

After the project intervention, the land price has increased due to the increased productivity of land. Though exogenous factors like macroeconomic development and inflation have contributed to raise the land price in general, people's increased interest to buy those land is acknowledged to be one of the reasons of rise in land price.

Impact

Due to flash flood protection and enabling environment for HYV rice culture, value of land has appreciated by more than thrice the pre-project price. Presently, the price of agricultural land per Keyar (30 decimals) is around BDT 1.5 lakh to BDT 2 lakh whereas the price of homestead lands learnt as BDT 2 lakh to BDT 3.0 lakh per Keyar.

8.6 Agriculture Crop Production base Income

Pre Project

Livelihood opportunities for households in the Kalikota haor region were limited and highly seasonal, as they were focused predominantly on agricultural labour associated with the single annual rice cropping cycle. Fishing was traditionally an important occupation for the people of haor region. The incidences of livestock husbandry as a livelihood activity in the haor region were also prominent as their tertiary source of income before the intervention.

Post Project

After project intervention, the income opportunity based on agriculture increased and people got chance to grow more paddy and recruit local labor, generating extra income opportunities for the wage earning households. People who have more land can grow more crops after the project.

Following table 8.2 shows the agricultural income based on land ownership stratum. Based on current production rate (per decimal), agricultural income has been calculated and

[1] 1 Keyar = 30 decimals

presented in this table. According to this table, the category of landless people did not get opportunity in both before and after project situation. Marginal farmer (farmers who own 0.004 – 0.198 ha land) depend on sharecropping of land owned by the others. Marginal farmer category shows a 5% rise in population (25% before and 30% after project). The reason is learnt to be a proliferation in this category entering from small farmer group who sell out land to owners of upper categories due to high cost of production they cannot afford. Even they become landless when they sell all their land for sustenance. There are some autonomous factors like population growth and distribution of property through inheritance play the major role in the changes of land ownership. Hence is the increase in absolute landless group by 5%.

Table 8.2: Agricultural income based on land ownership spectrum in Kalikota haor

Land Ownership Stratum	Households (%)		Income (agriculture base)	
	Base Conditions	After Project	Before Project (BDT)	After Project (BDT)
Absolute Landless(0 ha)	15	20	-	-
Functional Landless and Marginal farmer (0.004 – 0.198 ha)	25	30	5402	8410
Small farmer (0.202 - 1.008 ha)	35	25	32306	83760
Medium farmer (1.012 – 3.032 ha)	15	15	107939	251953
Large farmer (3.036 ha and above ha)	10	10	162070	252289

Source: Field data, 2017 through FGD, KII, and Informal Interview

The increased income of different land-size groups due to project interventions has been estimated. Standard five land size categories have been used and net increase in yield of rice crop due to improved cultural environment is shown in **Table 8.3.** Net Increase in Agricultural income By Category of Land Owners in Kalikota haor is presented below:

Table 8.3: Agricultural labour demand and labour based income

Land Ownership Stratum	Average size of land (ha.)	Increased Yield/ha (ton)	Total Increased Production(ton)	Price/ton (Tk)	Total Additional Income (Tk)
Absolute Landless(0 ha)	0.1	0.2	0.0	21400	432
Functional Landless and Marginal farmer (0.004 – 0.198 ha)	0.6	0.2	0.1	21400	2589
Small farmer (0.202 - 1.008 ha)	2.0	0.2	0.4	21400	8654
Medium farmer (1.012 – 3.032 ha)	6.5	0.2	1.3	21400	27897
Large farmer (3.036 ha and above ha)	0.1	0.2	0.0	21400	432

Impact

Every year flooding and water logging condition, especially during the March-April (time of *Chaitra* and *Baishakh,* Bengali Month), used to damage agricultural production very often before the project and therefore, the income opportunity of agricultural households declined. The opportunities for agricultural labor were also limited during the time of before project condition for the same reason.

After project intervention, people got enabling environment to grow more paddy and recruit local labor generating extra income opportunities. So the income opportunity based on agriculture has increased with project. People who have more land can grow more production during the project period.

8.7 Income from Agricultural Wage Labor

Pre Project

Before the project intervention, only the local varieties of paddy were cultivated in the study area. On that time there was no technological innovation or modern input/implement used for crop production. It was found that net demand for labor per ha was near about 130 person for the crop cultivation.

Post Project

After intervention, the total crop and cropping pattern have positively changed. Net demand for agricultural labor (having with technological innovation) has increased compared to the pre-project situation. The demand for agricultural labour is near about 160 (for HYV Aman, Local Aman, Hybrid Boro, and HYV Boro) per ha and most of the labor come from the local areas. The income from wage of labor for other regions have increased after the project intervention.

Impact

Regular flooding and water logging condition especially during the time of *Chaitra* and *Baishakh* (Bengali Month) inflicted damage to agricultural production before the project and, therefore, the income opportunity of agricultural households declined. The opportunities for agricultural labor were also limited during the time of before project condition.

After project intervention, people got enabling environment to grow more paddy and recruit local labor generating extra income opportunities. So the income opportunity based on agriculture has increased with project. People who have more land can grow more production during the project period.

8.8 Transport and Communication

Pre Project

Before intervention, people mostly used boat during the rainy season, and specific transportations system was not available during that period. People used to go to their desired places on foot in the dry season. The roads for using any kinds of vehicle were not available. Most of the social occasions were held during rainy season only to avail opportunities of using boats.

Post Project

After the period of project intervention, people started to use those submergible embankment as road to go to school, highways, bazaar and health centre etc. Though those embankments were not suitable for driving automobiles, people got opportunity to ply with auto rickshaws and bikes during the dry season. But in wet season, boat is the main sources of transport and communication in this region.

Figure 8.1: A submergible road and an embankment road that also used as the means of communication in Kalikota Haor, Sunamganj

With the period of time, mostly in the last 5 to 10 years, the damage to those submergible embankments has been severely and school going students, pedestrians, children and women have been facing problems to use those embankment as road during the early monsoon period.

Impact

The communication has improved over the pre-project situation due to its proximity to the Derai upazila sadar. The BWDB's submersible and compartmental embankments are playing main role in communication across the haor. This has expedited the transportation of goods and harvests too far off places at low cost. Moreover, accessing schools and clinics has become relatively easier for children and patients along the embankment at least when flood water recedes.

8.9 Institution and Governance

Bangladesh Water Development Board (BWDB) was responsible for physical implementation of water sector projects in haor region. Of late, Department of Haor and Wetland Development has been created. As apex institutions, these two have been administering all plans and projects in haor region.

Pre Project

Before the project intervention, local government organization like union Parishad or Thana Parishad existed with mandate to look after haor water resources. Regular inundation by flood waters was almost a regular phenomenon in haor area. Leasing of Jalmahals was the prime activity of those institutions for raising revenue of the government. It was only after BEDB was created that the issues of water development came in.

Post Project

After the project implementation, Water Development Board started to develop, manage and monitor the project activities in Kalikota haor. Their role for operation and maintenance was regular with the completion of submergible embankments. Presently, it has been found from the consultation with primary stakeholders that those institution are visible only during the period of damage and to monitor the physical condition of those embankments after the flooding condition. According to the local people, the officials from this institution t do not consult with the local people for lessening the damaged area of those submergible embankments.

Impact

The presence of BWDB and the Water Management Group has some institutional impact on the beneficiaries of the haor project. Overseeing the operation and maintenance of the infrastructures is the main function of those institutions. But the condition of physical infrastructures of the haor is reported to be running below the desired level.

9. Summary of Impacts

Table 9.1: Summary of Impacts

Indicators	Pre-project	Post-project	Impact
Water Resources			
Flooding	▪ Before implementation of the project, the haor was inundated frequently by flash flood during middle of March to early in April.	▪ After implementation of submersible embankment and regulators by BWDB in 1993, entrance of flash flood into haor got delayed by 9 to 10 days. However, due to under section of the embankment, the delay of entrance of flash flood has reduced by 2-3 days.	▪ Interventions of the haor have delayed the entrance of flood water and saved the crops from damage. However, due to under section of the embankment, the delay of entrance of flash flood has reduced by 2-3 days.
Drainage	▪ Most of the flood water smoothly drained out to the peripheral rivers such as Piyain, Surma and Mora-Gang, through the drainage khals and some water stored in the low-lying beels.	▪ The drainage of the haor has deteriorated a little bit. However, Most of the haor area is drained by the 1st week of February.	▪ The drainage of water of the area has become slower than before but not impacted largely. The drainage of the southern side of the haor has deteriorated in the downstream side as the sluice gate is not working properly.
Sedimentation	▪ The sediment carried by the flash flood got deposited both in the rivers and haor area. Hence, sedimentation inside the haor and in the peripheral rivers and Khals was not that much problem before implementation of the interventions.	▪ Sedimentation has taken place in the river and khals over the years. As a result the bed level of the peripheral rivers and khals has risen and conveyance capacity has also been reduced.	▪ Sedimentation has increased in the peripheral rivers as well as beds of connecting khals and beels compared to pre-project condition.
Navigation	▪ There was navigational connectivity between the haor and the nearby rivers throughout the year. During monsoon, it was the major mode of communication of the local people.	▪ There are no changes in navigational connectivity of the haor and the peripheral river during monsoon and limited navigation also takes place through the breached points	▪ The navigational connectivity has not been affected in monsoon but it does not operate during pre-monsoon due to repair of submersible embankment. Moreover, navigation in the peripheral river has not been affected.

Indicators	Pre-project	Post-project	Impact
		and public cuts upto February/March before repair. Moreover, navigation in the peripheral river has not been affected. However, navigational connectivity does not persist during pre-monsoon due to repair of submersible embankment. ▪ However, communication system has improved tremendously in dry season, due to construction of submergible embankments.	
Land Resources			
Land use (ha)	▪ Agriculture: 14984 ha ▪ Waterbodies: 1073 ha ▪ Forest: 1377 ha ▪ Settlement: 365 ha	▪ Agriculture: 14963 ha ▪ Waterbodies: 931 ha ▪ Forest: 1409 ha ▪ Settlement: 496 ha	▪ Agriculture: -21 ha ▪ Waterbodies: -142 ha ▪ Forest: 32 ha ▪ Settlement: 131 ha
Land degradation (Sand Carpeting area), ha	NA	NA	NA
Agriculture Resources			
Cropping intensity (%)	100	108	+8
Cropped area (ha)	▪ Rice: 14,984 ▪ Non Rice: 0	▪ Rice: 16,164 ▪ Non Rice: 0 ▪	▪ Rice:+1,180 ▪ Non Rice: 0 ▪
Crop production (ton)	▪ Rice: 45,700 ▪ Non Rice: 0	▪ Rice: 76,742 ▪ Non Rice: 0	▪ Rice:+31,042 ▪ Non Rice: 0
Crop damage (ton)	▪ Rice: 2.248 ▪ Non Rice: 0	▪ Rice: 12,210 ▪ Non Rice: 0	▪ Rice:+9,963 ▪ Non Rice: 0
Irrigated area (ha)	▪ Rice: 14,984 ▪ Non Rice: 0	▪ Rice: 14,963 ▪ Non Rice: 0	▪ Rice:-21 ▪ Non Rice: 0
Surface water Irrigation availability	▪ Available	▪ Deficit during month of February to March	▪ Deficit
Agro-chemicals use (ton or kilolitre)	▪ Fertilizers: 0 ▪ Pesticides: 0	▪ Fertilizers: 630 ▪ Pesticides: ▪ i) Granular: 76 ▪ ii) Liquid:3,067	▪ Fertilizers: +630 ▪ Pesticides: i) Granular: +76 ii) Liquid:+3,067
Livestock Resources			

Indicators	Pre-project	Post-project	Impact
Livestock population (number)	▪ Cattle: 18,510 ▪ Goat: 1,560 ▪ Chicken: 34,310 ▪ Duck: 32,300	▪ Cattle: 23,790 ▪ Goat: 1,110 ▪ Chicken: 42,440 ▪ Duck: 24,640	▪ Cattle: +5,280 ▪ Goat: -450 ▪ Chicken: +8,130 ▪ Duck: -7,660
Fisheries Resources			
Fish habitat area	• Total fish habitat area-16,057 ha • Habitat area breakdown: ○ River & Khal- 391 ha ○ Perennial Beel-634 ha ○ Floodplain- 14,984 ha ○ Baor-48 ha	• Total fish habitat area-15,879 ha, • Habitat area breakdown: ○ River & Khal- 99 ha ○ Perennial Beel-532 ha ○ Floodplain-14,963 ha ○ Borrow Pit- 175 ha ○ Fish Pond -11 ha ○ Baor-99 ha	• Loss of total fish habitat area by 178 ha (Decreased beel and khal's depth and converted in floodplain)
Habitat Condition	▪ Habitat quality and suitability condition was in favor of fisheries; ▪ Maintained unregulated ecosystem with better provisioning (i.e., fish) and supporting (i.e., fish nursery and breeding grounds) services like sustainable fisheries.	▪ Habitat quality and suitability condition becomes little degraded; ▪ Regulated ecosystem with somewhat degraded and unsuitable habitat condition particularly for Beel resident fishes; ▪ Increased pollution load due to intensified Boro cultivation.	▪ Slightly degraded habitat condition driving towards relatively less sustainable mentioned provisioning and supporting services.
Fish Diversity	▪ More or less evenly distribution of fish species over the area.	▪ Abundance of some biologically and commercially important fish species become low or rare locally; ▪ Population of bentho-pelagic like Notopterus chitala, Labeo calbasu,Labeo rohita, etc. and demersal fish species like Heteropneus fossilizes, Clarius batrchus, Channa punctatus, Macrognathus aculeatus, etc. become affected more due to	▪ Little imbalance in fish species distribution over the area; ▪ Vulnerability to Beel resident bentho-pelagic and demersal fish species; ▪ Possible inbreeding problem due to increase of culture exotic fish species.

Indicators	Pre-project	Post-project	Impact
		dewatering of Beels and indiscriminate fishing in Beel leasing system; ▪ Increased abundance of SIS fish species.	
Fish migration	▪ Unregulated lateral fish migration from river to floodplain and vis-à-vis through Khal; ▪ Regulated lateral fish migration from internal Khal to Beel and Beel to Khal by making earthen closure at the mouth of Khals by Beel Leaseholders (LH).	▪ The project is almost fully functional. For this reason, fish migration from river to Beel and Beel to river in the pre-monsoon season is being obstructed due to embankment and water control structures.	▪ There is no significant implication of interventions on fish migration particularly for SIS.
Fish Production	▪ Fish production in 1989 was about 1,584 metric ton.	▪ Fish production in 2015 was about 6,266 metric ton.	▪ Overall fish production gained is about 4,681 metric ton in 2015 compared to production of 1989.
Fishing Appliance	▪ Sustainable fishing was done using suitable mesh sized fishing gears. ▪ Fishing pressure at the mouth of the Khals during recession period were very low except leased Beel connecting Khals (only by LH).	▪ Unsustainable fishing is being done using small mesh sized fishing gears like Kona jal /Mosquito net (mesh size in mm); ▪ Fishing pressure at the water structure points during recession period is more because of engagement of mass people.	▪ Increased use of unconventional fishing appliances and thus increased fishing pressure.
Fishers Livelihood	▪ Commercial fishers were dominant in floodplain fish habitat meaning livelihood fully dependent on fishing. ▪ Fishing people were less.	▪ Part-time fishers become dominant in floodplain fish habitat meaning carrying livelihood with fishing is not adequate and need other income generating activities. ▪ Fishing people are more.	▪ Fishing based livelihood of commercial fishers becomes unsustainable due to dominancy of part-time fishers.
Fisheries Management	▪ Beel fishery maintained three-year rotation in harvesting fish;	▪ Beel fishery is being maintained mostly one-year rotation in harvesting fish.	▪ Beel fishery is being secured by the project though the weak enforcement is not yielding expected benefit.

Indicators	Pre-project	Post-project	Impact
	▪ Fish got more time for propagation and grow up; ▪ Sustainable fishery.	▪ Fish is not getting enough time for propagation and grow up; ▪ Unsustainable fishery.	
Ecosystem			
Terrestrial flora	▪ Floral diversity was optimum.	▪ Floral diversity enriched specially on homesteads and ridge vegetation	▪ Overall floral diversity and coverage has been changed insignificantly.
Terrestrial fauna	▪ Faunal diversity and coverage were pretty high	▪ Diversity of terrestrial fauna has been reduced over time	▪ Faunal diversity has been reduced due to agricultural expansion, planting exotic and other human interference. But the overall change is not directly linked with intervention activities.
Aquatic flora	▪ Aquatic floral diversity were enriched especially on free floating and rooted floating plants were abundant	▪ Aquatic floral diversity have been reduced over time	▪ Overall aquatic floral diversity has been changed due to over extraction, agriculture expansion and other anthropogenic activities
Aquatic fauna	▪ Aquatic faunal species were enriched throughout the area	▪ Aquatic faunal community have changed and lessened over time	▪ Overall faunal diversity and coverage are insignificant changed
Swamp Forest and Reed land	▪ No swamp forest but reeds coverage specially on binna, Ikor, Nol, khagra etc. and their density were enriched	▪ Wetland trees and reeds have changed positively at eastern part but remaining areas of the haor lost swamp forest and reed land density and coverage	▪ Over harvesting of economically valuable plants Reed land has converted into agricultural land. No direct link with intervention.
Ecosystem goods and services	▪ Ecosystem goods and services were in optimum level.	▪ Ecosystem goods and services has been reduced over time for different anthropogenic activities.	▪ Overall ecosystem goods and services have changed but no direct link with intervention.
Socio-economic Conditions			
Employment Opportunity	Total cropped area was 14984 ha whereas about 130 man days labour (per hector) inputs were needed.	Total cropped area were 16,164 ha where about 160 man days labor input were needed (technological use)	▪ Employment opportunity has been created during the period of operation and maintenance of those projects in Kalikota Haor ▪ New employment opportunity had been created with the increase of agricultural production

Indicators	Pre-project	Post-project	Impact
Labor and Seasonal Migration	▪ People from different regions came to join as work force for crop harvesting and fishing labors. ▪ Before intervention, people mainly engaged in agriculture. ▪ The Net demand for labor per ha near about 120 in the basis of agricultural production.	▪ The net demand for agricultural labor (having with technological innovation) is near about 160 per ha in the basis of agricultural production.	▪ The demand for labor would have to be increased. ▪ The technological innovation in agriculture was increased that increased the labor demands simultaneously. ▪ The net demand for agricultural labor (having with technological innovation) is near about 160 per ha whereas most of the labor come from the local areas. ▪ The incoming rates of labor from other regions were being increased after the time of project intervention.
Agriculture and wage base income	▪ The total agricultural production base average income were about BDT 13710 lakh ▪ The agricultural wage base average income was about 5394 lakh.	▪ The agriculture production base income after the period of after project is about BDT 23023 lakh ▪ The agricultural wage base average income is 7431 lakh	▪ Agricultural production base income was increased due the project intervention. ▪ Agricultural wage labor income increased during the period of after project condition.
Land Price	▪ The price of agricultural land was 6000 to 7000 Tk per Keyar	▪ The price of agricultural land is near to be 1.0 lakh to 2.0 lakh whereas the price of 2.0 lakh to 3.0 lakh for homestead lands.	▪ The opportunities for agricultural production were increased in which the value of agricultural lands was being increased with the period of after project condition.
Accessibility in Health and Educational institution	▪ It was tough to go to the schools and health institutions especially in the dry season.	▪ People started to use the embankments as their way of communication. ▪ With the damage of the certain locations of the embankments people felt unsecured to use their way of moving during the rainy season. ▪ School going children sometimes fall in problem in using	▪ The communication system became easier after the time of project intervention. ▪ Due to lack of proper maintenance, the damage of the embankments was increased and local people started to face problem to use these embankments as their means of communication.

Indicators	Pre-project	Post-project	Impact
		embankments as their way to go to schools.	
Institution and Governance	▪ There was no institutional governance as there was no intervention (i.e. Submergible embankment)	▪ The institutions (i.e. WDB) started to work and monitor the damage during the post flooding time. ▪ The Governance had the gap from the corners of local people. ▪ There was no participation with the local stakeholders from policy to implementation	▪ The practice of good governance is unavailable that lead to increase damage of those embankments ▪ There is no mechanism to understand local people's concern in terms of project operation and maintenance. ▪ The role of institution to consider public demand in policy, operation and maintenance on the issue of those submergible embankments.

10. Environmental Management Plan

Table 10.1: Management Plan

Impact	Mitigation Measures	Enhancement Measures
Flooding	• The submersible embankment should be repaired as per design section within the month of February every year. • Causeway should be constructed at suitable locations to avoid major damage of embankment by public cuts. • The Beels, Khals and rivers should be dredged/ re-excavated to increase carrying capacity.	
Drainage and Sedimentation	• Internal Khals and peripheral rivers should be re-excavated and required number of sluices should be constructed. • Regulators at Balanpur and Daudpur should be repaired to facilitate drainage	
Navigation	• Some *ghats* should be constructed at suitable locations and some navigation friendly culverts should be constructed over the embankment. The outlets should have boat pass facility to maintain navigational connectivity.	
Land use change	• Agricultural land graving should be avoided. • Fallow land should be brought under cultivation	-
Decreased cropped area	• Raise the height of the submersible embankment up to 2 to 3 feet at Bilanpur to Bagmara (Atgaon) locations. • Complete the rehabilitation work by the months of December-February.	-

Impact	Mitigation Measures	Enhancement Measures
	• Kanda should be utilized for vegetables cultivation. • Hydroponics or floating bed vegetables cultivation should be introduced. • Medium high and medium low land should be utilized for short duration and submergence tolerant T Aman (BINA dhan7, BINA dhan 11, BINA dhan12 and BINA dhan 13) cultivation. • Flood tolerant submergence variety (BRRI dhan51, BRRI dhan52 and BRRI dhan79 may be tested.	
Increased crop production	-	• Crop area should be increased by utilization of fallow land. • Short duration high yielding and hybrid varieties should be developed/introduced/strengthened. • Crop damage should be minimized by timely and proper rehabilitation of water control structures like embankment , regulators etc.
Decreased irrigated area and Availability of irrigation water	• Regular re-excavation/dredging of Mara Gang and Piyain rivers has to be ensured in order to retention of irrigation water.	• Re-excavation of existing Beels and Khals should be ensured for retention of irrigation water. • Irrigation water should be ensured by stopping draining out of the Beels during early dry season for fish harvesting.
Status of livestock/poultry		• Grazing area should be increased by utilizing fallow land. • Awareness buildup through training • Marketing facilities should be improved. • Availability of high yielding breed should be ensured.
Increased crop damage	• Functioning and maintenance of sluice	

Impact	Mitigation Measures	Enhancement Measures
	gates under Balanpur and Atgaon mouza's. • Regular dredging of the rivers has to be ensured in order to reduce the intensity of flash flood. • Rehabilitation works should be finished by February • Quality materials should be used for rehabilitation works. • Short duration high yielding or hybrid varieties should be used instead of long duration BRRI dhan29 variety. • Local varieties should be transplanted in the deeper part of the Haor area instead of short height high yielding or hybrid variety.	
Increased use of agro-chemicals	• Farmers should be encouraged to use organic manure to increase soil fertility while avoiding water contamination and reduce the soil fertility. • Farmers should be encouraged to cultivate leguminous crops to enhance the soil quality. • Farmer should follow modern agricultural technology like Integrated Pest Management/Integrated Crop Management (IPM/ ICM), Good Agricultural Practices(GAP) etc.	
Loss of total fish habitat area by 426 ha (Decreased Beel and Khal's depth and floodplain converted into upland/homesteads)	• Re-excavation of internal Khals and channel and seasonal Beels	• Not applicable
Slightly degraded habitat condition driving towards less sustainable provisioning services majorly fisheries.	• Water holding capacity in the Khals and in some cases in the Beels (i.e., Chatal Beel, Char Kaman Beel, Kalikota Beel, Piyan Beel, Khali Beel, Gatua Beel, Chata Beel etc.)	• Not applicable

Impact	Mitigation Measures	Enhancement Measures
	should be increased through re-excavation/ dredging; • Maintain minimum 1 m water depth in almost all water bodies during dry season.	
Vulnerability to Beel resident bentho-pelagic and demersal fish species	• Unconventional fishing appliances (i.e., fine meshed gears, dewatering, poisoning, etc.) should be banned; • Should motivate and encourage agriculture sector people for abstaining from use of chemical fertilizers and pesticides for keeping water uncontaminated.	• Beel nursery programme with native fish species should be increased; • Build more sanctuary with the involvement of adjacent fishers community; • The protected area should be guarded especially at night by the professional fishers of adjacent village for facilitating fish species diversity and fish propagation.
There is no significant implication of interventions on fish migration.	• Increase the conveyance capacity of Khal maintaining minimum 1m depth during dry season; • Fish friendly structures should be implemented for suitable fish passage. • Fishing should be controlled during pre-monsoon and recession period.	• Proper maintenance work should be conducted and monitored by the Project Implementation Committee (PIC). • Monitoring and awareness building activities should be conducted through fishers' communities under the guidance of Upazila Fisheries Officer.
Overall fish production gain is about 5,710 metric ton in 2015 compared to production of 1989.		• Beel fishery should be promoted with three-year rotation; • Beel dewatering should be stopped.
Increased use of unconventional fishing appliances and thus increased fishing pressure.	• Unconventional fishing appliances should be stopped; • Should increase law enforcement for controlling unlawful fishing. • Strong surveillance for maintaining water control structures through controlling fishing.	• Not applicable
Fishing based livelihood of commercial fishers becomes unsustainable due to dominancy of part-time fishers.	• Fishing ban time income generating activities should be promoted. In that case, the fisher's community should be involved in water management group.	• Not applicable
Beel fishery is being secured by the project though the weak	• The project should be maintained with the	• Not applicable.

Impact	Mitigation Measures	Enhancement Measures
enforcement is not yielding expected benefit.	coordination of the line agencies.	
Overall floral diversity and coverage are insignificant changed	• Plantation of local species in the project areas (i.e. Settlement ridge, Roadside, Kandas etc.) needs to be done as early as possible. • Tree based farming may established • Use of natural fertilizer is required rather than chemical fertilizer	• Local species should give preference for all types of plantation.
Faunal habitat deteriorated most of the area for different anthropogenic activities except eastern portion of the Haor.	• Avoid killing of animals • Use of natural fertilizer instead of chemical fertilizer is essential	• Aware local people for indigenous tree plantation and conserving wildlife • Initiate plantation programme along the river levees, Kandas and other khash lands
Overall aquatic floral community has been changed due to over extraction, agriculture expansion and other anthropogenic activities	• Aware local people about the importance of aquatic resources • Control over harvesting of aquatic plant resources	
Overall faunal diversity and coverage have been insignificantly changed	• Aware local people about conservation of aquatic animals and their sustainable harvesting of aquatic flora. • Use of natural fertilizer in the land	
Over harvesting of economically valuable plants, Reed land has converted to agricultural land.	• All the khash land with swamp forest and reed lands should be out of public lease and allotments	• Local household should be involved in transit nursery program for proper seed germination and saplings collection. • BFD, BWDB, local people, local nursery owner should be properly involved in the collaboration of plantation program inside the Haor area • Create new swamp forest area
Overall ecosystem goods and services have reduced	• Conservation of reed land and important wetland areas • Avoid over harvesting of economically valuable plants • Use of natural fertilizer	
(Livelihood and employment opportunity)	-	• Training would be ensured for the creation of alternative livelihood options

Impact	Mitigation Measures	Enhancement Measures
• New employment opportunity had been created with the increase of agricultural production • Employment opportunity has been created during the period of operation and maintenance of those projects in Kalikota Haor.		• Submergible embankment must be repair using the local labor • Allocation of all Beel /Jall Mohal to the actual fishermen on equity basis • Soft loan would be provided especially in the emergency period (i.e. post flooding condition) • Build up linkage with farmer and national, international traders
(Labor and Seasonal Migration) • The demand for labor would have to be increased. But here it is noted that after the period of project intervention, • The net demand for agricultural labor (having with technological innovation) is near about 160 per ha whereas most of the labor come from the local areas. • The incoming rates of labor from other regions were being increased after the time of project intervention.	**-**	• Skill development training program should be initiated for capacity building especially for women to make them capable to earn money at home. • Affordability through the soft loaning mechanism should be ensured to earn foreign currency sending the labor in foreign market • Provide loan services by low interest to promote young entrepreneurs as their alternative livelihood options.
(Agriculture and wage base income) • Agricultural production base income was increased due the project intervention. • Agricultural wage labor income increased during the period of after project condition.	-	• New variety in production with the changes of seasonality should be initiated • Innovative training programs should be initiated to cope up with the changing technology
(Land Price) • The opportunities for agricultural production were increased in which the value of agricultural lands was being increased	-	• Regular Maintenance and protection work should be implemented properly to keep the land arable • The siltation during the flash flood would be controlled

Impact	Mitigation Measures	Enhancement Measures
with the period of after project condition.		through the development of regular monitoring system.
(Accessibility in Health and Educational institution) • The communication system became easier after the time of project intervention. • Due to lack of proper maintenance, the damage of the embankments was increased and local people started to face problem to use these embankments as their means of communication.	-	• A monitoring Committee should be formed in association with WDB and local people to identify damaged area. • A hot line (i.e. calling system) should be developed to get regular update, flooding condition and damage information during the emergency • Design of operation and maintenance (i.e. Submergible embankment) would be ensured through the participation of local stakeholders
(Institution and Governance) • There is no mechanism to understand local people's concern in terms of project operation and maintenance. • The role of institution to consider public demand in policy, operation and maintenance on the issue of those submergible embankments. • The practice of good governance is unavailable that lead to increase damage of those embankments	• Quarterly Meeting should be initiated with local water and flood protection committee to understand the gap of institutional policy and governance • A Monitoring team should be formed to visit during the maintenance of those submergible embankments • People's feedback should be taken before the implementation of any kind of policy in relation to new project and maintenance and operation of those submergible embankments.	-

Appendix A

Table A1: Availability of major fish species in Kalikota Haor (but not limited)

Sl. No.	Local Name	Scientific Name	IUCN Status, 2015
1	Ayre	*Sperata aor*	VU
2	Bacha	*Eutropiichthys vacha*	LC
3	Baghair	*Bagarius bagarius*	CR
4	Baila	*Glossogobius giurus*	LC
5	Bajari Tengra	*Mystus tengara*	LC
6	Barobaim	*Mastacembalus armatus*	EN
7	Boal	*Wallago attu*	VU
8	Catla	*Catla catla*	LC
9	Chapila	*Gudusia chapra*	VU
10	Chang	*Chana orientalis*	LC
11	Chital	*Chittala chittala*	EN
12	Darkina	*Esomus dandicus*	LC
13	Ghoinya	*Labeo gonius*	NT
14	Gojar	*Channa marulius*	EN
15	Gutum	*Lepidocephalichthys guntea*	LC
16	Kabashitengra	*Mystus cabasius*	NT
17	Kachki	*Corica soborna*	LC
18	Kaikla	*Xenentodon cancila*	LC
19	Kajuli	*Ailia coila*	LC
20	Kalibaus	*Labeo calbasu*	LC
21	Kanipabda	*Ompok bimaculus*	EN
22	Kashkhaira	*Chela laubuca*	LC
23	Katari Chela	*Salmostoma bacaila*	LC
24	Kholisa	*Colisa fasciatus*	-
25	Koi	*Anabas testudineus*	LC
26	Kuchia	*Monopteruscuchia*	VU
27	LalChanda	*Chanda ranga*	-
28	Lalkholisa	*Colisalalius*	-
29	Magur	*Clarias batrachus*	LC
30	Mrigal	*Cirrhinus mrigala*	NT
31	Mola	*Amblyphayngodon mola*	LC
32	Nandil, Nandi, Nandina	*Labeo nandina*	CR
32	Napit koi	*Badis badis*	NT
33	Potka	*Tetradon cutcutia*	LC
34	Rani	*Botia dario*	EN
35	Rita	*Rita rita*	EN
36	Rui	*Labeo rohita*	LC
37	Shilong	*Silonia silondia*	LC
38	Shing	*Heteropneus fossilies*	LC
39	Shol	*Channa striatus*	LC
40	Tara baim	*Macrognathus aculatus*	NT
41	Tengra	*Mystus vittatus*	LC
42	Tit puti	*Puntius ticto*	LC
43	Veda/ Mani	*Nandus nandus*	NT
	Etc.		

Appendix B: Photo Album


Water Resources


Agriculture Resources


Fisheries Resources


Ecological Resources


Socio-economic Resources


Key Informant Interview

Re-excavation of Singua River

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1. Introduction

1.1 General Information

The Singua River project involves re-excavation of the Sigua river and drainage canal. The project lies in between longitude 24°25'59.54"N and 24°15'15.40"N and latitude 90°39'57.10"E and 90°49'27.97"E under Kishoreganj District. The project has a gross area of 15,545 ha of which about 118 ha is perennial beels/haor, 50 ha ponds, 18 ha rivers and khals, 6106 ha is occupied by rural settlement, 9187 ha is herbaceous crop and rest of the part is brickfield.

The Singua River traverses through Kishoreganj Sadar, Pakundia and Katiadi Upzila. The project provides benefits to these three Upzilas and to a part of Nikli Upzila. The Singua River receives most of the water from the Old Brahmaputra River. There are a lot of beels in the project area, especially in the southern side. These beels, Aingadi Khal and the Old Brahmaputra River have created a complex network of the drainage system. Major beels situated in this projects are Ghaldaba Beel, Chaytikbali Beel**,** Kahetardia Beel, Ramerpuri Beel, Katakhali Beel, Naothaghya Beel, Diga Beel, ShilmariBeel, Gari Beel and Raua Beel.

1.2 Problems of the Project

The main problem of Singua River is sedimentation. Almost 4 decades have passed since the excavation work. The inhabitants in the project area got the better output of the excavation work till the year 2000. After then, sedimentation problem started developing in Singua River. Little by little the bed of the river started rising. In recent time, the depth of the river has become almost half and coincidently the conveyance capacity of the river has reduced. There is no problem of flash floods in the project area, but during the monsoon some of the areas in the project get flooded. The flood water in the monsoon takes time to drain out completely because of this reduction in the conveyance capacity of the river. There is no problem of erosion in the project area. Singua River is not used for navigation purpose, so there is no problem in terms of navigation also.

1.3 Project Descriptions

The major interventions of the project are re-excavation of entire length of the Singua River and 50 km of drainage Khals. The re-excavations were carried out during 1976 -1979 by Bangladesh Water Development Board (BWDB). The aim of re-excavation was to increase the water conveyance capacity of the river. The project provided benefits to about 15545 ha of land.

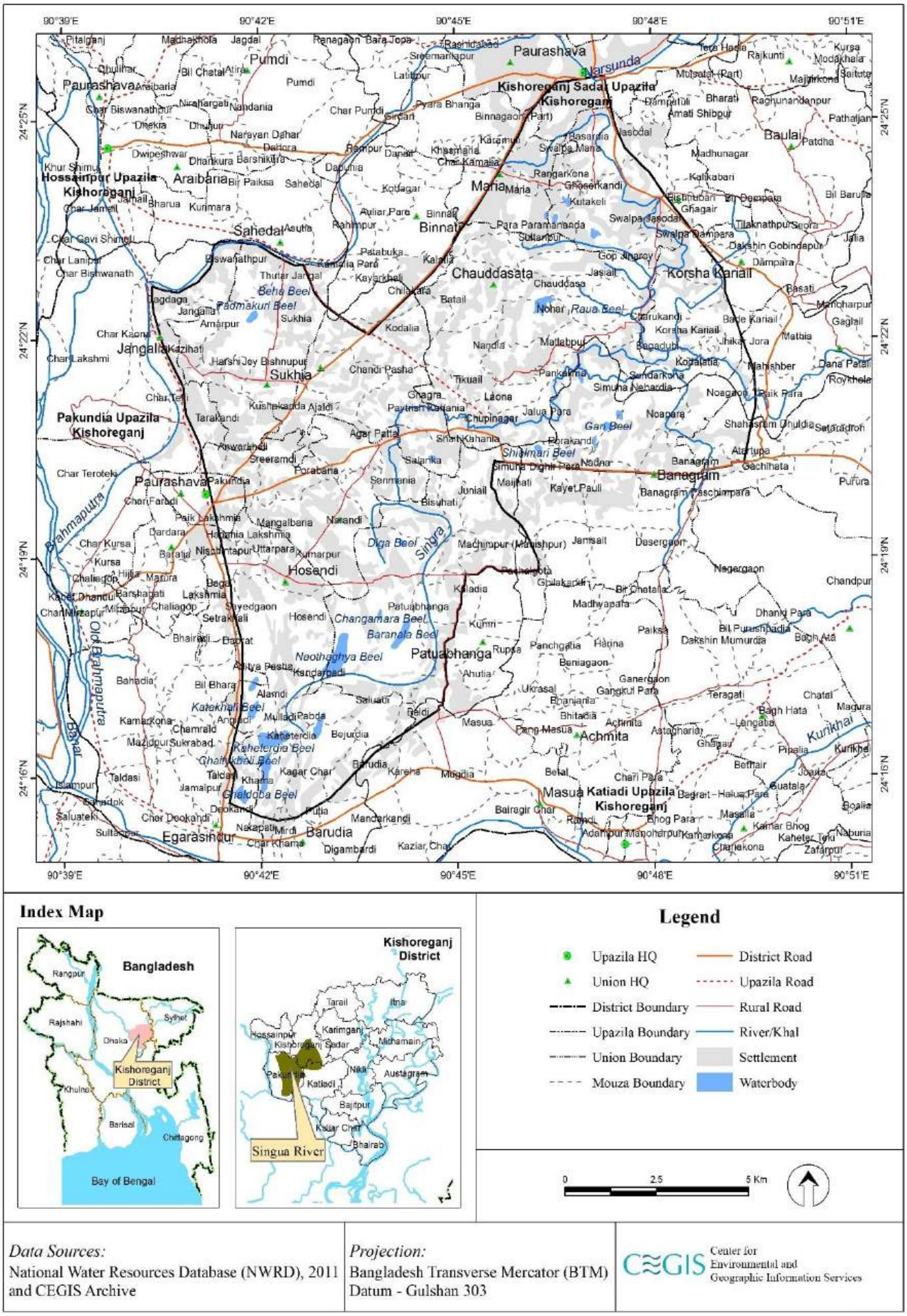

Figure 1.1: Hydrologic features of Singua River System

2. Water Resources

2.1 Flooding

Pre Project

The main source of water in Singua River is the Old Brahmaputra River which flows along the east side of the Singua River and is connected through Bahadia sluice gate. Before re-excavation of Singua River, flooding usually occurred in the monsoon season and had a huge impact on the area adjacent to the river. Due to shallow draft, almost 60% of the areas of Muladi, Pabda, Kagar Char, Kahetardia - situated close to the beels, were inundated badly. The level of water reached up to 5 feet at that time During July-September. Rest of the time was almost free from flooding.

Post Project

The flooding has improved after the re-excavation. The benefits of the re-excavation lasted for about 20 years, up to 2000. The water conveyance capacity increased in most of the reaches of the river which helped to contain the flood and facilitated agricultural activities. Later, the areas in Muladi, Pabda, Kagar Char, Kahetardia gets flooded in the monsoon. It is alleged that, the agricultural land near the river gets flooded by up to 2 feet in the years of heavy rain. A sluice gate in Bahadia cannot start operating until the water level reaches a certain height of about 20 feet. In this time the downstream area gets flooded up to a maximum height of about 3 feet.

Impact

There was an improvement on flooding after the re-excavation of Singua River and Khals but the benefits of this improvement started declining in recent years as the bed of the river and Khals has risen due to siltation.

2.2 Drainage

Pre Project

The drainage of water through the Singua River was hindered before the re-excavation work in the early 70s. The narrow drainage path in Bahadia beel area was not adequate to carry the water away from the river which impeded and delayed draining to the Singua River.

Post Project

The re-excavation of the Singua River and Khals in 1979 smoothened the drainage of water. This continued for 20-25 years. However, the drainage is being impeded for the last 10-12 years. Moreover, it was found during the field visit that the farmers are taking possession of the river by filling it up leading narrowing the river. Construction of a bridge near the connection point of Ramerpuri beel and Singua River has narrowed the river also. Due to accumulation of siltation, the gates of sluice gate in Bahadia cannot operate timely which hampers the drainage facility of the river. As a result, the downstream area in Mulladi and Angiadi is suffering from water logging even in the dry season. It was also observed that the people living near the river area, has blocked the drainage path with wooden fence and earthen dam to cultivate fish hindering the natural drainage of the water.

Figure 2.1: Fish Cultivation with Wooden Fencing in the middle of the River

Figure 2.2: Narrowing the Width of the River by Constructing Bridge near Ramerpuri Beel

Impact

The drainage has been impacted due to discontinuation of maintenance excavation as well as intervention of local people in terms of encroaching the river by land filling and for fish culture.

2.3 Sedimentation and Siltation

Pre Project

The depth of the Singua River decreased badly due to sedimentation over the years which caused rise of river water level and consequently flooding. The northern part of the project, i.e. the upstream of Singua River was affected more compared to the southern part near the meeting point of the river with the Old Brahmaputra.

Post Project

Soon after the excavation of the river, the depth of the river increased up to 35 feet at certain places. This increased the conveyance capacity of the river appreciably and made the river lively. However, over the last 4 decades no maintenance excavation was carried out after 2000 resulting rising of bed level. The average depth of the river has decreased to 15 to 18 feet, even a depth of 5 feet is seen in Muladi area. This situation is causing inundation in the river adjacent area, the agricultural land beside the river in particular.

Impact

The river bed has risen due to non-discontinuation of maintenance excavation causing flooding and loss of agricultural products.

2.4 Navigation

Pre Project

The Singua River was never a major navigation route. Before the re-excavation of the river, small boats were used to catch fish. There were no other uses of boats or any other water vessels.

Post Project

The scenario of navigation has not changed too much even after re-excavation of river and khals. In recent time, cockles are used to carry Jack-Fruits in the monsoon to the nearest markets from different villages. Excessive water hyacinth, settlements in the middle of the river, fish culturing with ring fence etc. are obstructing the plying of boats through the river.

Figure 2.3: Water Hyacinth

Figure 2.4: Earthen Passage in the Middle of the River

Impact

The re-excavation of the Singua River and Khals have not impacted on navigation in the project area.

3. Land Resources

The project area has fallen in two Agro-ecological zone, namely: Young Brahmaputra and Jamuna Floodplain (AEZ-08) and Old Brahmaputra Floodplain (AEZ-9). Non-calcareous grey floodplain soil (non-saline) and non-calcareous dark grey floodplain soils are the dominant soil. The top soil texture is clay, clay loam and loam; where clay loam texture is dominant. The soils are moderately permeable and have a medium to high moisture holding capacity. The land type characteristics are not uniform within the project area. About 70% of cultivable areas are medium to high land where maximum flooding depth is below 90 cm during the monsoon period. The recession of surface water from agriculture land starts at first week of October and become free of flood water in end of December.

Two indicators (Land use and Sand carpeting area) have been selected for assessing the impact on land resources due to structural interventions in Haor ecosystem. The land use and sand carpeting information under pre-project and existing situations were identified through analysis of the available archived satellite images of CEGIS and it was verified through Focus Group Discussion (FGD) and Key Informant Interview (KII).

3.1 Land Use

Pre-project

The gross area of pre project has been considered as similar to post project. The gross area was 15,545 hectare under pre-project situation of which Net Cultivated Area (NCA) was 9,476 hectare. The rest area was covered with water bodies (Baor, Beels, river and Khals), forest (herb, shrub and tree) and settlements including homestead vegetation. Details are presented in Table 3.1.

Post-project

The gross area remaining same and the Net Cultivated Area (NCA) is 9,179 hectare. The rest area are covered with waterbodies (Baor, Beels, river and Khals), forest (herb, shrub and tree), and settlements including homestead vegetation. Details are presented in Table 3.1.

Impact

Net cultivated area has decreased about 297 hectare. On the other hand, water bodies and rural settlement area have increased about 82 and 154 hectare respectively. Detailed impacted area is presented in Table 3.1.

Table 3.1: Detailed land use in Singua River system

Land use	Pre-project area(ha)	Post-project area(ha)	Impact (Post-project-Pre- project)
Net Cultivated Area (NCA)	9,476	9,179	-297
Water bodies	112	194	82
Settlement	5953	6106	154
Others	4	65	61
Total	**15,545**	**15,545**	**0**

Sources: Analysis 30 m Resolution Landsat Satellite Images, March: 1989 and 2015

3.2 Land Degradation

No sand carpeting was found before or after implementation of the project.

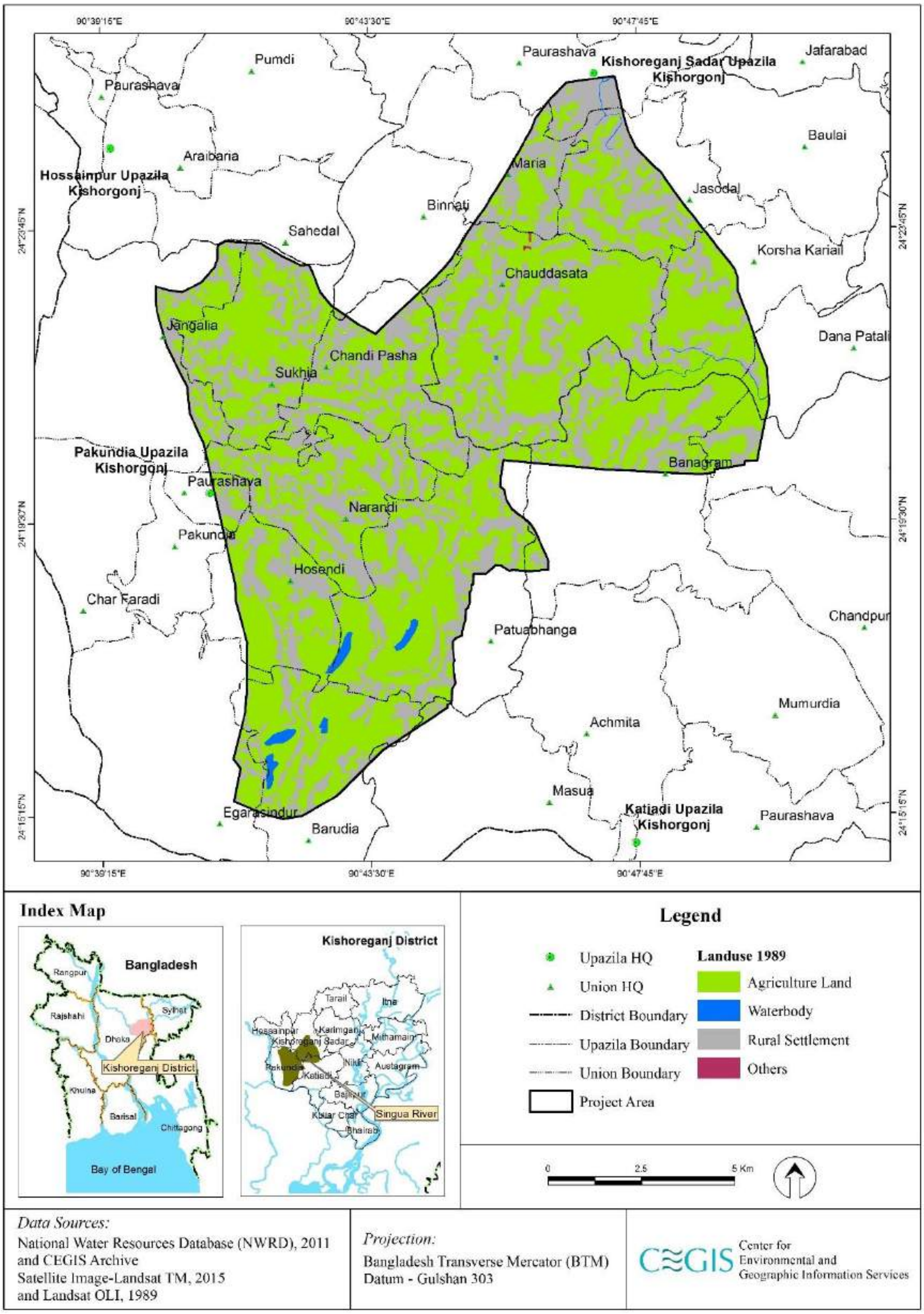

Figure 3.1: Land use of Singua River System (1989)

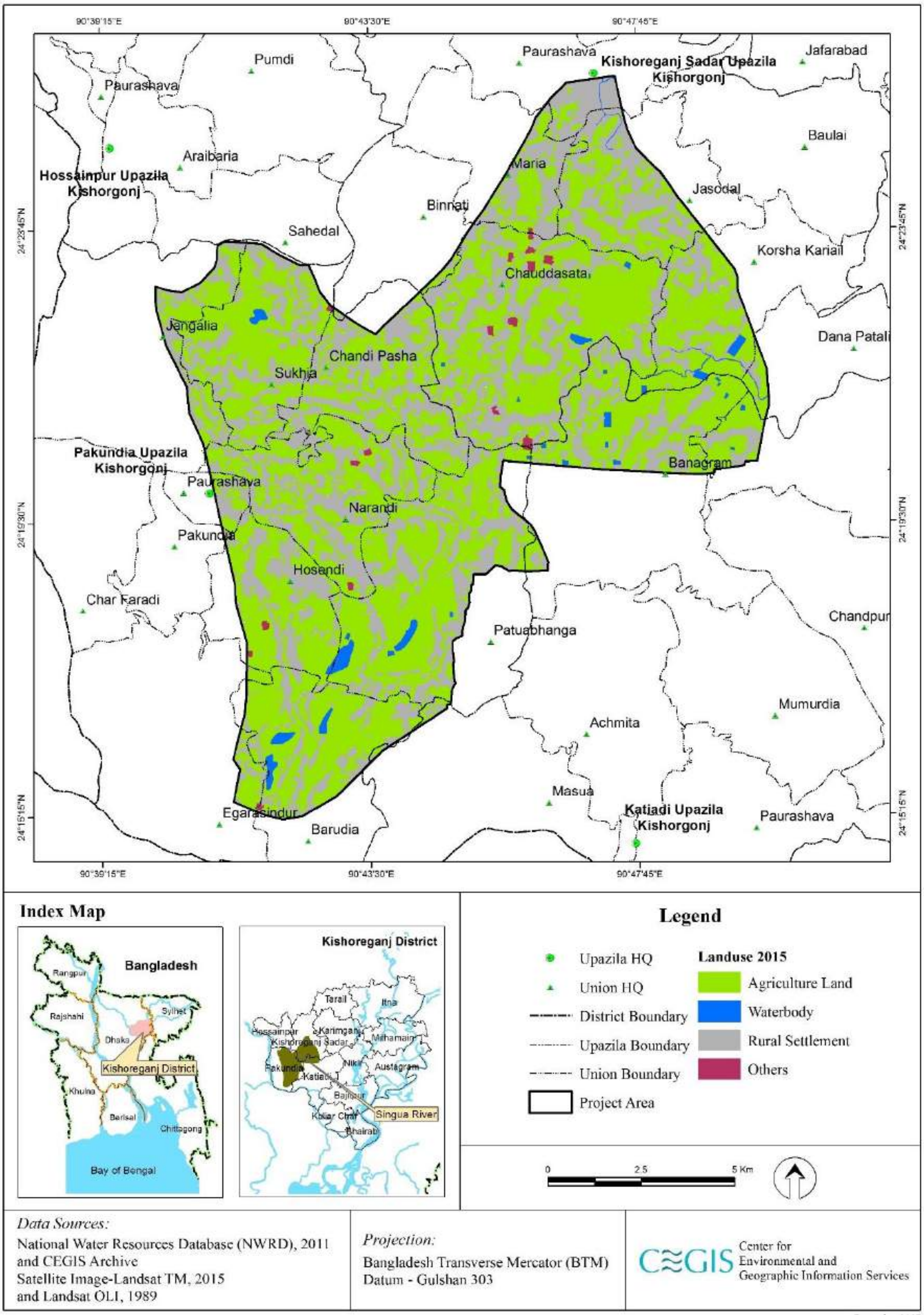

Figure 3.1: Land use of Singua River System (2015)

4. Agriculture Resources

Boro rice is the main crop in Haor areas. In most cases, pre-matured or matured Boro crops are damaged by early flash flood which generally happened due to pre-monsoon heavy rainfall in the hilly areas. Besides, drainage congestion and irrigation water scarcity due to siltation of rivers, Khals and Beels are the another problem for Haor agriculture.

Six indicators (cropping intensity, crop area, crop production, crop damage, irrigation and use of agro-chemicals) have been selected for assessing the impact on agriculture resources due to structural interventions in Haor ecosystem. The information of these indicators were collected from both primary and secondary sources. The primary data were gathered from stakeholders through Focus Group Discussion (FGD) and Key Informant Interview (KII). The secondary data were collected from Bangladesh Bureau of Statistics (BBS) and field level Department of Agricultural Extension (DAE) office.

4.1 Cropped Area, Cropping Pattern and Intensity

Pre-project

Before the project interventions, the Net Cropped Area (NCA) was 9,476 ha, where dominating cropping pattern Jute- Fallow- Local Boro and Fallow- Lt. Aman- Fallow was found. The land type of this project area was low land (about 46% of NCA) followed by low land, medium low land, medium high land as presented in Table 4.1.

Farmers usually grew Lt. Aus, Lt. Aman, Local Boro, Jute, potato, pulses and vegetable crops in Kharif-I, Kharif-II and Rabi season. Different varieties of Aus like Murali, Murabata, Haowa (B. Aus) and Hasbada (B. Aus)l; Aman like Maloti, Gandi, Panjab, Kalizira, Birukhail, Khilloi and Bawaha (B. Aman); Local Boro like Gochi, Boro, Tepi Boro, Rata, Kali Boro, Paizam and Akhnishail were very much popular among the farmers. The cropping intensity of this area was 191%. Detailed cropping pattern by land type under pre-project situation is presented in Table 4.1.

Table 4.1: Pre-project cropping pattern of the Singua River system

Land type	Kharif-I (March-June)	Kharif-II (July-October)	Rabi (November-February)	Area (ha)	% of NCA
High Land (F_0)	Fallow	Lt. Aman	Fallow	1,712	18.1
	Fallow	Lt. Aman	Vegetables	1,460	15.4
	Lt. Aus	Lt. Aman	Pulses	1,092	11.5
Medium High Land(F_1)	B. Aus	B. Aman	Pulses	878	9.3
	Fallow	B. Aman	Potato	1,520	16.0
Medium Low Land(F_2)	Jute	Fallow	Local Boro	1,753	18.5
Low Land(F_3)	Fallow	Fallow	Local Boro	1,023	10.8
Very Low Land(F_4)	Fallow	Fallow	Fallow	38	0.4
Total				**9,476**	**100.0**
Cropping intensity (%)				**191**	

Source: CEGIS estimation based on field information, November; 2017

Post-project

The project area became protected from early flash flood due to the interventions, which influenced farmers to grow HYV Aman, Hybrid/HYV Boro crops instead of B. Aman/Lt. Aman and local Boro respectively. HYV/hybrid Boro crops also produces higher yield than local varieties. Farmers usually prefer short duration HYV varieties i.e. BRRI dhan 28, BRRI dhan 29, BRRI dhan49, BRRI dhan48 and BRRI dhan52. Farmers prefer, Lt. Aman:Khilloi, Kalizira, Paizam and Hafsail;HYV Aman: BRRI Dhan 32, BRRI Dhan 48, BRRI Dhan 49, BRRI Dhan 52 in Kharif-II season, HYV Boro: BRRI dhan 28, BRRI dhan 29 in Rabi season. Moreover, Hybrid Boro (Hira and Jholok) varieties are introduced in this area but not become as popular as HYV variety.The Net Cultivable Area (NCA) has been decreased to 6,256 hectare after interventions. Dominant cropping pattern of the project area is Fallow- HYV Aman- HYV Boro covering 17.2% of the NCA. The cropping intensity of this area is 233%. Detailed cropping pattern by land type under post-project situation is presented in Table 4.2.

Table 4.2: Post-project cropping pattern of the Singua River system

Land type	Kharif-I (March-June)	Kharif-II (July-October)	Rabi (November-February)	Area (ha)	% of NCA
High Land (F_0)	Fallow	HYV Aman	Potato- HYV Boro	643	7.0
	Fallow	HYV Aman	Potato-Vegetables	1,090	11.9
	Fallow	HYV Aman	Vegetables	820	8.9
	Fallow	HYV Aman	HYV Boro	1,578	17.2
Medium High Land(F_1)	Jute	HYV Aman	Pulses	862	9.4
	Jute	Lt. Aman	HYV Boro	1,460	15.9
Medium Low Land(F_2)	Fallow	Lt. Aman	Hybrid Boro	688	7.5
	Fallow	Lt. Aman	HYV Boro	1,010	11.0
Low Land(F_3)	Fallow	Fallow	HYV Boro	992	10.8
Very Low Land(F_4)	Fallow	Fallow	Local Boro	36	0.4
Total				**9,179**	**100.0**
Cropping intensity (%)				**233**	

Source: CEGIS estimation based on field information, November; 2017

Impact

The Net Cultivable Area (NCA) has been decreased to 297 hectare after taking interventions. The cultivated area of Local Boro has gradually been decreased and replaced by HYV Boro variety after completion of project due to its higher yield rate and ensured early flash flood protection by project interventions. Impact on cropped area is presented in Table 4.3.

Table 4.3: Impact on cropped area in Singua River system

Crop name	Pre-project Area (ha)	Post-project Area (ha)	Impact (Post-project - Pre-project) Area (ha)
B. Aus	878		(878)
Lt. Aus	1,092		(1,092)
B. Aman	2,398		(2,398)
Lt. Aman	4,264	3,158	(1,106)
HYV Aman		4,993	4,993

Crop name	Pre-project Area (ha)	Post-project Area (ha)	Impact (Post-project - Pre-project) Area (ha)
Hybrid Boro		688	688
HYV Boro		5,683	5,683
Local Boro	2,776	36	(2,740)
Jute	1,753	2,322	569
Pulses	1,970	862	(1,108)
Potato	1,520	1,733	213
Vegetables	1,460	1,910	450
Total	**18,111**	**21,385**	**3,274**

Source: CEGIS estimation based on field information, November; 2017

4.2 Crop Production

Pre-project

The estimated total annual crop production of the project area was about 69,428 tons after loss of 12,259 tons before any interventions. Detailed crop production statistics before interventions is presented in Table 4.4.

Table 4.4: Annual crop production in Singua River system under pre-project situation

Crop name	Total crop area (ha)	Damage free area		Damaged area		Annual production (ton)	Production lost (ton)
		Area (ha)	Yield (ton/ha)	Area (ha)	Yield (ton/ha)		
B. Aus	878	702	1.8	176	0.8	1,405	176
Lt. Aus	1,092	819	2.1	273	0.9	1,966	328
B. Aman	2,398	1,918	1.9	480	1.1	4,173	384
Lt. Aman	4,264	3,241	2.3	1,023	1.0	8,477	1,330
Local Boro	2,776	1,999	2.8	777	1.2	6,529	1,244
Jute	1,753	1,402	2.2	351	0.8	3,366	491
Pulses	1,970	1,675	1.3	296	0.6	2,354	207
Potato	1,520	1,186	18.0	334	6.0	23,347	4,013
Vegetables	1,460	1,051	15.0	408.80	5.0	17,812	4,088
Total	**18,111**	**13,993**	**-**	**4,118**	**-**	**69,428**	**12,259**

Source: CEGIS estimation based on field information, November; 2017

Post-project

After the implementation of the project, hydrological regime of the project area is changed. Farmers started to cultivate HYV crops due to presence of submersible embankment, compartmental embankment, regulator and closure, which protect their crops from early flash flood. Hence, total annual crop production is about 114,146 tons with loss of 15,965 tons after interventions. Detailed estimation of crop production after interventions is presented in Table 4.5.

Table 4.5: Annual crop production in Singua River system under Post-project situation

Crop name	Total crop area (ha)	Damage free area		Damaged area		Annual production (ton)	Production lost(ton)
		Area (ha)	Yield (ton/ha)	Area (ha)	Yield (ton/ha)		
Lt. Aman	3,158	2,590	2.5	568.44	1.1	7,099	796
HYV Aman	4,993	3,994	3.5	998.60	1.2	15,179	2,297
Hybrid Boro	688	564	5.8	123.84	1.5	3,458	533
HYV Boro	5,683	4,490	3.8	1,193.43	1.4	18,731	2,864
Local Boro	36	28	2.8	7.92	1.4	90	11
Jute	2,322	1,974	2.3	348.30	1.0	4,888	453
Pulses	862	733	1.4	129.30	0.8	1,129	78
Potato	1,733	1,386	22.0	346.60	10.0	33,967	4,159
Vegetables	1,910	1,433	18.0	477.50	8.0	29,605	4,775
Total	**21,385**	**17,191**	**-**	**4,194**	-	**114,146**	**15,965**

Source: CEGIS estimation based on field information, November; 2017

Impact

Additional 44,717 tons crops are being produced in post project situation. The crop production is increased due to the protection of flash flood which encourages the farmers for practicing high yielding variety instead of local variety. Detailed estimation of impact on crop production is presented in Table 4.6.

Table 4.6: Impact on crop production in Singua River system

Crop name	Pre-project Production(ton)	Post-project Production(ton)	Impact (Post-project-Pre-project)
B. Aus	1,405		-(1,405)
Lt. Aus	1,966		-(1,966)
B. Aman	4,173		-(4,173)
Lt. Aman	8,477	7,099	-(1,378)
HYV Aman		15,179	15,179
Hybrid Boro		3,458	3,458
HYV Boro		18,731	18,731
Local Boro	6,529	90	-(6,439)
Jute	3,366	4,888	1,522
Pulses	2,354	1,129	-(1,225)
Potato	23,347	33,967	10,620
Vegetables	17,812	29,605	11,793
Total	**69,428**	**114,146**	**44,717**

Source: CEGIS estimation based on field information, November; 2017

4.3 Crop Damage

Pre-project

Flash flood was the main cause of crop damage in pre-project situation. Before harvesting of Boro rice or Robi crop, water entered into the haor area and damaged the crops. So, farmer of this area suffered due to damaging of their crops in every year. Total crop damage in the project area was 12,259 tons annually. Detailed estimation of crop damage is presented in Table 4.4

Post-project

Singua River is now protected from early flash flood by the project interventions which basically performed well up to 2010. After 2010, flood water enters into the project area before harvesting of Boro crop (early to mid-March) due to low height of submersible embankment and silted up of Singua River.

Floodwater enters into the project area through the Singua River by overtopping or by breaching the embankment at several locations. The main reason for flooding in this area over the years is that the rivers have silted up and their water flowing capacities are gradually reducing. The excessive sedimentation makes rivers incapable of holding and conveying floodwater, which creates excessive pressure on earthen embankment.Moreover, plant height of hybrid/HYV is less than local varieties and growing period of most of the Hybrid/HYV varieties are higher than local varieties except BRRI dhan28. So, flood water affects the whole crop area at a time. The devastating floods of 2004 inundated the project area on the mid week of April. Local people reported, around 50% of Boro both HYV and local varieties were damaged by the devastated flood and late flood damaged the seedbed of T Aman and around 40% of the T Aman cropwas also fully damaged in this year due to sudden rise of the floodwater and wave action. In 2007, around 60% of Boro both HYV and local varieties were damaged by the devastated flood. But, this year (2017), around 90% of Boro crop areas are damaged at pre-mature stage. Most vulnerable mouzas such mulladi, Kagar char, Kandapadi, Bil Bahar, Angiadi and Saluadi are identified in this respect. Total crop damage is recorded as 15,965 tons after interventions. Detailed estimation of crop damage after interventions is presented in Table 4.7.

Impact

Though, the crop damage area has been decreased from 23% to 20% after interventions. However, crop damage has been increased 3,706 tons because the total production has increased significantly. The crop damage area is increasing day by day due to malfunctioning of the interventions and reduced water carrying as well as retention capacity of surrounding rivers, khals and beels. Detailed impact assessment on crop damage is presented in Table 4.7.

Table 4.7: Impact on crop damage in Singua River system

Crop name	Pre-project Production loss (ton)	Post-project Production loss (ton)	Impact (Post-project – Pre-project)
B. Aus	176		(176)
Lt. Aus	328		(328)
B. Aman	384		(384)
Lt. Aman	1,330	796	(535)
HYV Aman		2,297	2,297
Hybrid Boro		533	533
HYV Boro		2,864	2,864
Local Boro	1,244	11	(1,233)
Jute	491	453	(38)
Pulses	207	78	(129)
Potato	4,013	4,159	146
Vegetables	4,088	4,775	687
Total	**12,259**	**15,965**	**3,706**

Source: CEGIS estimation based on field information, November; 2017

4.4 Irrigation

Pre-project

Before initiation of the project, surface water was sufficient for irrigation in this project area. Farmers of the study area were cultivated Aus, Aman, Boro, Jute, pulses, potato and vegetables in that situation. Local farmer reported that they stored water with help of bundh/dyke management and irrigated their crop with the help of flooded water in the low lying part of the Haor. They also used traditional modes like *Seuti, Don and Cone* for irrigating their crop from surrounding rivers, Beels and Khals during dry season. Prior to the implementation of the project, irrigation water was more available than the requirement of crops.

Post-project

After implementation of the project, the irrigation water demand has been increased due to cultivation of high water demanding HYV Boro instead of Local Boro crop. On the other hand, the availability of surface water is being reduced due to siltation of surrounding rivers, khals and beels of the project area. Therefore, the scarcity of irrigation water has been observed from early February to end of March in most of the year. In this time, Singua River are the main source of surface water irrigation. Mainly Low Lift Pumps (LLPs) is being used for lifting surface water instead of traditional mode. Now the main source of irrigation is ground water which covers 75% area. BADC irrigation system covered near about 40% of this area (Khagar char, Pakundia, Sodhgaon, Angidia) and rest area covered by commercially developed DTW irrigation system.

Impact

There was deficit of irrigation water due to increase of water demand and decrease of water availability during dry season. The irrigation water demand has increased for cultivating high yielding crop variety. On the other hand, surface water irrigation availability has decreased due to siltation of rivers, khals and beels of the project area.

4.5 Agro-chemicals Use

Pre-project

Farmers of the project area cultivated Aus, Aman, Boro, Jute, Potato, Pulses and Vegetables in pre-project situation. They didn't apply agro-chemicals for crop cultivation. However, some farmers used inorganic fertilizer like mixed grass and rice straw in the crop field for the restoration of soil fertility.

Post-project

Generally more agro-chemicals are required for cultivating HYV/Hybrid crops. So, farmers applied more agro-chemicals for HYV/Hybrid crop cultivation. Total about 7,520 tons chemical fertilizers, 28 Kiloliter liquid and 37 tons granular/powder pesticides were used in the study area for crop cultivation per year. Detailed use of agro-chemicals under post-project situation is presented in Table 4.8.

Table 4.8: Use of agro-chemicals in Singua River system under post-project situation

Crop name	Fertilizer (Kg/ha)				Total (kg/ ha)	Pesticides	
	Urea	TSP	MP	Others		Liq. (ml/ha)	Gran. (Kg/ha)
Lt. Aman	160	80	80	8	328	1000	1
HYV Aman	180	100	100	12	392	1000	2
Hybrid Boro	240	125	125	20	510	1500	3
HYV Boro	220	110	10	18	358	1500	2
Local Boro	180	90	90	10	370	1200	1
Jute	100	30	60	5	195	1500	1.5
Pulses	20	20	30	5	75		
Potato	160	60	160	15	395	1800	2
Vegetables	200	120	150	15	485	2000	2

Source: CEGIS estimation based on field information, November; 2017

Impact

Use of agro-chemical has increased largely under post-project situation compared to pre-project situation. Additional about 7,520 tons chemical fertilizers, 28 Kiloliter liquid and 37 tons granular/powder pesticides are used for crop cultivation annually. Detailed impact on use of agro-chemical is presented in Table 4.9.

Table 4.9: Impact on agro-chemicals in Singua River system

Crop name	Pre-project			Post-project			Impact		
	Total Fertilizer (ton)	Pesticides		Total Fertilizer (ton)	Pesticides		Total Fertilizer (ton)	Pesticides	
		Liquid (KiloLiter)	Powder/ Granular (ton)		Liquid (KiloLiter)	Powder/ Granular (ton)		Liquid (KiloLiter)	Powder/ Granular (ton)
Lt. Aman	0	0	0	1,035.82	3.16	3.16	1035.824	3.158	3.158
HYV Aman	0	0	0	1,957.26	4.99	9.99	1957.256	4.993	9.986
Hybrid Boro	0	0	0	350.88	1.03	2.06	350.88	1.032	2.064
HYV Boro	0	0	0	2,034.51	8.52	11.37	2034.514	8.5245	11.366
Local Boro	0	0	0	13.32	0.04	0.04	13.32	0.0432	0.036
Jute	0	0	0	452.79	3.48	3.48	452.79	3.483	3.483
Pulses	0	0	0	64.65	-	-	64.65	0	0
Potato	0	0	0	684.54	3.12	3.47	684.535	3.1194	3.466
Vegetables	0	0	0	926.35	3.82	3.82	926.35	3.82	3.82
Total	**0**	**0**	**0**	**7520.12**	**28.17**	**37.38**	**7520.12**	**28.17**	**37.38**

Source: CEGIS estimation based on field information, November; 2017

5. Livestock Resources

Livestock and poultry, being an essential element of integrated farming system, play an important role in the economy of the Haor area. Livestock provides significant draft power for cultivation, threshing and crushing of oil seeds; cow dung as a source of manure and fuel; a ready source of funds; and meat, milk and eggs for human consumption. A large number of livestock are reared in Haor areas but constrained by flash flood causing inundation of large areas during most of the time in the year. This area is famous for duck rearing due to availability of natural feed for ducks in natural large water bodies. All of livestock species suffer much due to shortage of feed, outbreak of waterborne diseases and inadequate shelter facilities. The livestock rearer in the Haor areas do not get fair price due to poor communication as well as lack of marketing facilities.

The indicator status of livestock has been selected for assessing the impact of the project. The status of livestock population data were collected from Livestock Census (1986), Agriculture census (1996 and 2008) of BBS. The status of livestock feed and fodder, diseases, marketing facilities information were gathered from stakeholders through Focus Group Discussion (FGD) and Key Informant Interview (KII).

5.1 Status of Livestock Population, Feed and Diseases

Pre-project

According to livestock census 1996, the livestock and poultry population in the project area were 37,780 cattle, 22,750 goats, 150,260 chicken and 32,240 ducks (Table 5.1). Before implementation of the project, the major feed available to ruminants was mostly crop residues (rice straw) supplemented with weeds from cultivated fields. They are to depend on naturally grown grasses in Kandas and alongside roads and embankments. Most of the year before implementation of the project, the crops were to damage by early flash flood. As a result, shortage of feed from crop residues, reduction of grazing facilities seriously affect livestock rearing. That time, the small holders were to depend on water hyacinth and other aquatic plant for their cattle. The major poultry feeds were rice bran, broken rice, kitchen wastes like rice, rice-gruel, vegetables, fish wastes etc. In addition, the duck usually scavenge in the nearby waterbodies like haor, beel, khal, river or any other low lying areas; mainly eat various types of aquatic insects, small fish, shell or snails. Major livestock and poultry diseases were Gola Fula (Haemorragic Septicemia), Foot and Mouth Diseases (FMD), Pox and Cholera, Duck Cholera and Fowl Cholera etc. The most vulnerable period was between July to November for spreading diseases to livestock and poultry populations. Mortality rate of the livestock/poultry was higher due to poor shelter condition and they lived in unhygienic condition. Marketing facilities was not in good condition and price was also low due to less demand of their products and by products. Producer consumed their products at family level and additional products were sold at local village market.

Table 5.1: Status of livestock/poultry in Singua River system

Livestock/ Poultry Category	Pre-project		Post-project		Impact
	No of Households having Livestock	Total No of Livestock	No of Households having Livestock	Total No of Livestock	Number of Livestock Population
Cattle	17,280	37,780	21,480	45,310	7,530
Goat	11,380	22,750	9,920	19,090	-3,660
Chicken	26,190	150,260	29,910	165,110	14,850
Duck	9,520	32,240	9,200	33,240	1,000

Source: CEGIS estimation based on agriculture census (1996 and 2008)

Post-project

According to agriculture census 2008, the livestock and poultry population in the project area are 8,670 cattle, 1,860 goats, 34,070 chicken and 11,620 ducks (Table 5.1). After implementation of the project, crop is protected from early flash flood. As a result, the feed availability of livestock is increased due to increase of crop production. However, some of the year, the crops were damaged by early flash flood. In that year, the small holders were depend on water hyacinth and other aquatic plant for their cattle. The poultry feeds are same as in pre project situation. On the other hand, more or less similar diseases are found in post project situation. The mortality rate of the livestock/poultry became negligible during the project period, due to extension works at farmers' level such as immunization and insemination program by Department of Livestock (DLS). Marketing facilities during dry season also improved due to improvement of the communication system by constructing the submersible embankments. Therefore, market prices are increased due to high demand of products and by products.

Impact

From 1996 to 2008, about 7,530 cattle, 14,850 chicken and 1,000 duck have increased due to the reduction of flood vulnerability, improvement of marketing facilities and strengthening of livestock extension services. On the other hand the goat population has been decreased to 3,360. Details about impact on livestock are presented in Table 5.1.

6. Fisheries Resources

The River Singua is the main river in the project area. Fisheries resources in the river is comparatively poor and less diversified. Some perennial and seasonal beels, khals and floodplain and huge fish ponds are present in the project area. The river Brahmaputra is the main source of water in the project area. In monsoon, water entrance in the area from Brahmaputra river which is situated west side of the project area. And the rain water is another source of water in the project area. The river and the connected khals are act as fish migratory route as well as sheltering place of fish. In monsoon the floodplains are use as fish spawning and grazing area.

Some water logged area are present in Mulladi, Alamdi village area due to drainage problem. Overall the water body contribute little bit in respect of capture fisheries and ecology. Floodplain habitat in Mulladi and Alamdi village area that create fishing opportunity for fishers in monsoon and post monsoon period. In post monsoon the floodplain are use as crop field except the perennial area. Huge number of fish ponds are use as fish culture purpose and contributing vast in fish production.

During field visit the team members observed the field scenario and discuss with good numbers of local fishers, farmers, local elites in several spots to collect the past and present informations about the project area. The local community informed that the flood occurs due to heavy rain as well as the water enter from the Brahmaputra river. Source of water in the project area is same as past scenario. Fishing in the river area is almost open for everybody. Huge water hyacinth present at Mulladi and Alamdi village area where fishing is comparatively difficult because of water hyacinth and other aquatic weeds.

6.1 Habitat Area

In the project area the river play a vital role in respect of capture fish production. The major beels are namely Ghaldoba beel, Kahterdia beel, Alamdi beel, Katakhali beel, Katakhali beel, Naothaghya beel, Baranala beel, Digha beel, Gari beel, Raua beel, Padma kuri beel are present in the project area.

Some khals like Digha beeler khal, Sukhia khal, Raua beeler khal, Hidol chari khal are connected with the Singua River. Limited floodplain area is present at Mulladi and Alamdi village area. The river is perennial in nature but water depth is low in dry season and not enough for fish sheltering.

In floodplain at Mulladi, Alamdi village and adjacent area water stay about 4 to 5 months and uses as fish breeding and feeding ground. Huge water hyacinth are present in the Singua river and adjacent floodplain area that used as sheltering place for fish. The floodplain area are used as crop field in dry season.

Pre Project

Fish habitat of Singua River area was 1507 ha in pre Intervention period. Out of that capture fish habitat was 1506 ha and fish pond 1 ha. Overall fish habitat scenario was comparatively good. And the connectivity of khals with beel, floodplain and river was smooth.

Post Project

In post Intervention period the total fish habitat is 1877 ha. Of which 1827 ha capture fish habitat and 50 ha culture fish habitat. The water area increase due to siltation in the mouth of river. The connecting khals are silted up and loss the water holding capacity especially in dry season. In some area the land owners are converting the floodplain to culture fish habitat. And culture habitat is increasing day by day especially in Banagram, Noapara, Nadna village area. Huge water hyacinth present that disturb the fish movement. Photos of fish habitat of Singua River area are given below in Figure 5.1.

Figure 5.1: Fish habitat of Singua River

Table 6.1: Breakdown of fish habitat area by habitat type

Sl.	Fishery Category	Habitat type	Area (Ha)		Impact (Habitat area Change in Ha)
			Pre Intervention	Post Intervention	
1	Capture	Perennial Beels	93	118	+25
		River and Khals	18	25	+7
		Floodplain	1395	1684	+289
		Sub Total	**1506**	**1827**	**+321**
2	Culture	Culture habitat	1	50	+49
		Sub Total	**1**	**50**	**+49**
		Grand Total	**1507**	**1877**	**+370**

Source: Fish habitat assessment based on field findings and image based landuse data,1989 & 2015.

Impact

Increase of fish habitat is *370* ha in post Intervention period, which is increase about 25% of pre Intervention condition. Breakdown of fish habitat is given in the following Table 6.1.

6.2 Habitat Condition

Fish habitat condition is medium. But the status of water bodies are changing day by day due to human encroachment, siltation, and incremental crop cultivation and converting of floodplain to culture fish habitat and seed bed in the project area.

Pre Project

Use of agrochemicals and pesticides and fertilizer was very limited. Because mostly the farmer cultivate the local variety of rice and other crops. Fish habitat condition as well as water quality was good and productive.

Post Project

At present boro / crop cultivation is increasing. So increasing the use of agrochemicals, pesticides and fertilizer. And the residue of that agrochemicals are going to the river water bodies and decreasing the habitat condition and the water quality. In the other hand the water and the river fish habitat are polluted by different types of wastages from homestead, market which is decreasing the habitat and water quality.

Impact

Depth of water in Singua river is decreasing that decreasing the sheltering place of fishes. And the fish habitat and water quality also degrading for incremental use of agrochemicals, pesticides and fertilizer in crop field and wastage from different sources. That decrease the productivity of fish habitat.

6.3 Fish Diversity

Pre Project

During field visit the local fishers and the old age peoples reported that the abundance of the species was moderate. The available fishes was boal, puti, tengra, taki, magur, shing, baila, rui, catla, kalibaus kholisha, mani, koi, kakila, chanda, potca, guchi baim, tara baim, mola, gutum, deshi sarputi, pabda, chola puti, titputi, foli, darkina, chapila, chital, icha, chang /okol, shol etc. About 70 fish species was present in project area.

Post Project

The number of fish species are almost same as before. But changes the species richness. And some of the fish species are now available which was almost unavailable few years ago. Abundance of species like mani, deshi sarputi, pabda, boro baim etc. are increasing day by day. Basically diversity of culture fishes are increased. Photo of fish species in the river area are given in the following Figure 5.2.

Impact

Richness of some species increase like deshi sarputi, pabda, baro baim, mani, etc. And remarkable increased of culture fish diversity.

Figure 5.2 Available fish species in Singua River

6.4 Fish Migration

Pre Project

Overall fish migration and movement was smooth in the project area. There was no obstacle of fish migration from one place to another. Naturally the fish use the shallow depth for breeding and feeding purpose which is very essential for their life.

Post Project

Disturbing of fish migration due to establishment of new bridges on the road, culvert and siltation in river and khal bed. Floodplains are converting for fish culture habitat especially at Banagram and Noapara village area. So the spawning and feeding grounds are decreasing day by day. But at Mulladi, Alamdi and adjacent area spawning and feeding grounds of fish are comparatively good. Huge water hyacinth in the water that disturb the smooth movement.

Impact

Spawning and feeding grounds are decreasing that hampered the fish migration and movement. And delayed of fish breeding especially the small fishes.

6.5 Fish Production Assessment

Pre Project

Fish production was about *151* Metric Ton (MT) per year. Of which from capture habitat was about *150* MT and from culture habitat was about *1* MT per year.

Post Project

Total fish production is about *749* MT per year. Of which from capture habitat is about *529* MT and from culture habitat is about *220* MT.

Impact

Increase of fish production is about *598* MT per year. The incremental fish production may causes due to increasing of fishing activities, commercialization of fishing, increasing of pond culture and stocking of fish in the beel. Fish production from pre intervention and post intervention are given in the following Table 6.2.

Table 6.2: Breakdown of fish production by habitat type

Sl.	Category	Habitat type	Production (MT)		Impact (Production Change in MT
			Pre Intervention	Post Intervention	
1	Capture	Perennial Beels	49	103	+54
		River and Khal	3	5	+2
		Floodplain	98	421	+323
		Sub Total	**150**	**529**	**+379**
2	Culture	Culture habitat	1	220	+219
		Sub Total	**1**	**220**	**+219**
		Grand Total	**151**	**749**	**+598**

Source: Fish production assessment based on field findings and FRSS data 1989 and 2015.

6.6 Fishing Appliances

Pre Project

In this period overall the mesh size of net was above 2-3 cm (about 1 inch) that was used to catch fishes. Fishing gears like, koi jal, puti jal, khora, thela jal, jhaki jal, ber jal, borshi, Gui (made by bamboo that used to catch small fishes) was used to catch fishes from the Singua river and adjacent areas. All the nets was fish friendly and protect the small fishes during fishing. Lease system was absent.

Post Project

At present the fishers are using the gear which was almost used earlier. At present some new nets and traps like moshari jal (small mesh size net below 0.1 cm) that are using to catch the fish which are damaging the fish fry as well as habitat quality. *Kironmala* (one kind of trap made by plastic sheet and use fish feed inside the trap to catch fish) are using to catch gura icha. No lease system present.

Ber jal Trap

Figure: 5.3 Types of fishing gears of Singua River

Impact

New nets like moshari jal (small mesh size net) and kironmala (trap) is using that are damaging the fish fry as well as habitat quality.

6.7 Fishers Livelihood

Types of fishers like permanent, part time and subsistence fishers are involved with fishing activities in project area. Both Hindu and Muslim fishers are present. At present the number of Muslim professional fishers' are increasing. The professional fishers used to catch fish in the river area during monsoon and post monsoon period. After that they catch fish in ponds in the project area. The project area is comparatively reach in culture activities. The professional fishers are fully dependent of fishing for their livelihood round the year. And the part time fisher catch fish about 2-3 months after inundation of river and floodplain area. Rest of the time the part time fishers are engage with agriculture activities. The subsistence fishers catch fish only for own consumption.

Pre Project

The professional fishers was involve to catch fish in the river and adjacent area about 4-5 month per year. After that they catch fish in Brahmaputra river and culture pond especially in dry season. Most of the professional fishers was Hindu. The number of fishers was limited in pre intervention period. The Muslim professional fishers was few in number.

Post Project

The Hindu fishers are almost same as before. But at present, good number of Muslim fishers are involve with fishing as professional and part time fishers. And the number is increasing day by day. Monsoon and post monsoon is the main fishing time. But day by day number of part time fishers' are increasing rapidly in the Alamdi village, Mulladi village, Bejurdia village, because of water logged in the area. The part time fishers are mostly Muslim. Beside these some peoples are involved as retailer, fish labor, transport worker, fish aratder, ice producer, etc. for their livelihood. Good number of peoples are engage in fish culture activities in Banagram, Noapara, Jaluapara, Nadna, Chupinagar, village area. At present the local communities are involving more to pond fish culture as a supplementary income.

Impact

Increasing the part time fishers' number means increasing the fishing pressure in post Intervention period. Besides this some peoples are involving as fish retailer, fish aratder, ice producer, fish labor, transport worker etc. for their livelihood. Good number of peoples are involving in different activities. Overall the number is increasing.

6.8 Fisheries Management

Pre Project

Monsoon and post monsoon was the peak time for fishing. There was no restriction in fishing in this period. In that time fishing practices was almost smooth. Even some water area in the river was protected as safeguard for the brood fish for next year breeding. Fishing by dewatering in beels was almost absent.

Post Project

No restriction of fish catch in river area. But some are of the river are dried up during dry season. So sheltering place of fish is squeezing day by day and the fisheries resources are decreasing.

Impact

Fish habitat and save place for brood fishes are decreasing. Due to that fish production is decreasing.

7. Ecosystem

The Singua River plain roughly consists of 15545 hector area, which is mainly a flood plain area. The excavation of Singua river took part in the 1976-79 period. It brought favorable condition for the surrounding people, but in 10-15 years the siltation from various floods made the river bed filled up and the overall situation deteriorated. Singua river project area comprised of several khal and beel those are internally connected with each other. The project area possesses a unique ecosystem that supports various types of terrestrial and aquatic floral and faunal species. Terrestrial ecosystem belongs to different homesteads, kanda and roadside vegetations of the scattered settlement. The remaining flora is aquatic life-forms. There are some major beels in the project area, namely Kaheterdia, Padmakuri, Ramerpuri, Raua Beel etc. These beels plays a major role in existing ecological system. As a flood plain, the haor basin indicator flora and fauna were less present at this part of the project.

7.1 Terrestrial Flora

Pre Project

In homestead area the fruit yielding tree species was commonly found more than timber plants. Mango and jackfruit tree was most popular fruit yielding tree among others. The bushy shrubs like Nolkhagra, Dholkolmi, different herbs and grasses were commonly found over the area. Before intervention taken place in 1976, the study area was comprised of different terrestrial species but dominant tree species was naturally grown mainly the fruit yielding trees. The previous vegetation coverage area is much higher in the past.

Post Project

According to aged persons living in the area, the present vegetation coverage area is much higher than the past (before intervention) as homestead vegetation gradually increasing over time.The project area is abundant of fruit yielding and wood yielding trees. As fruit yielding trees, mango, jackfruit, banana etc commonly found and as wood yielding tree Rain tree, Shirish tree, Chambul tree found pretty common during filed survey.

A. Singua River filled with water hyacinth at Molladi Village

B. Roadside diversified flora

C. Water hyacinths collection from Ramerpuri Beel

Source: CEGIS field visit 3rd& 4th November, 2017

Figure 6.1: Present state of Singua river and its adjacent area

Impact

The interventions like the re-excavation of the river would be paving the way to enhance the diversity of flora. But the population density and their daily needs are downing the current status. Access to more people to harvest natural resources as per demands has been leading depletion of terrestrial floral coverage due to overexploitation. Therefore, the ultimate goal of the interventions was dismay. The specific impact on flora has been depicted below in Table 7.1.

Table 7.1: Changes of status of indicator species

Indicator Species	Pre Project	Post Project	Cause of status change	Type of Intervention that caused the change (If Yes)
Pitali/Mera	Common	Moderately found	Anthropogenic causes	-
Hizol	Common	Less common	-	-
Koroch	Occasional	Occasional	-	-
Barun	Common	Moderately found	-	
Dhol Kolmi	Common	Common	-	
Nol Khagra	Common	Less Common	Agricultural expansion	-

7.2 Terrestrial Fauna

Pre Project

Terrestrial vegetation was the shelter and roosted place for different bird species especially Pallas's Fish Eagle, Brahminy Kite, Vulture and other common birds. During winter, Bengal Fox, Big rat were frequently seen along crop field and bushy high lands. South-western part of Singua river area was favorable place for medium sized mammals like fishing cat, jackal and other wildlife. According to local elderly people, otter was very rarely seen inside area. The reptiles and amphibians population was also found good in number. Additional to other fauna, Bengal monitor lizard is a common reptilian species in this area.

Post Project

At the post intervention period, the terrestrial faunal status had been declining for some species and some species are increasing in number. Most of the dominant terrestrial fauna turned into threatened category those were available due to different anthropogenic activities. After implementation of interventions, it had paved the way to produce more crops instead of keeping lands unproductive. As a consequence, terrestrial fauna lost their suitable habitats where they build nests, groom for breeding and take parental care to their offspring. But commonly available terrestrial birds like Black Drongo, Common Myna, Asian Pied Starling, Oriental Magpie Robin, Spotted Dove, House Sparrow, Common Tailorbird, etc. has been sighted good in number and their population remains almost similar in comparing pre-intervention period. Among the reptiles, the Indian Rat Snake, Checkered Keelback, Common Garden Lizard, House Lizard, Skink, Bengal Monitor, are reported to be commonly found in the area. The amphibians inhabit in various habitats from human settlement to agricultural lands and even in ditches. The frog and toad species those are commonly observed in the area are Common Toad, Indian Bullfrog, and Cricket Frog etc. Two mammalian species i.e. Otter and Fishing cats are not commonly seen in this area (source: local people) which was less common 30 years ago.

Source: CEGIS field visit 3rd & 4th November, 2017

Figure 6.2: View of commonly seen bird species; Left: Brahminy Kite and Right: Common Pond Heron

Impact

The facilities provided by the intervention namely excavation embankment, sluice gate, regulators; etc has given the opportunity to other sectors for harvesting best service but for a small window of time. But in the bigger aspect it has been indirectly triggered fauna into diminishing to the threat of extinction. Also, siltation due to monsoon flood and water logging has become a continuous problem since last 15 years. A specific status of the terrestrial fauna is presented in Table 7.2.

Table 7.2: Impact on terrestrial fauna of the Singua river project

Indicator Species	Pre Project	Post Project	Cause of status change	Type of Intervention that caused the change (If Yes)
Pallas's Fish Eagle	Common	Occasional	Habitat loss	-
Brahminy Kite	Very Common	Common	-	-
Vulture	Rare	Not found	Habitat destruction and effect from cattle medicine	-
Fishing Cat	Occasional	Occasional	Habitat loss	-
Bengal Fox	Very Common	Common	Killing, habitat loss	-
Checkered Keelback	Common	Moderately found	-	-

7.3 Aquatic Flora

Pre Project

The sample respondent opines that (those who can recall the river valley scenario before intervention taken place), the aquatic bodies were full of different floral groups especially in Kaheterdia, Padmakuri, Ramerpuri, Raua Beel etc. The floral vegetation like Water Chestnut, Water Caltrop or commonly called Singara (*Trapa natans*) and White Water Lily were abundant because most the land was fallow not to use for cultivation. Sometimes, flash floods occurred and made damaged to many floral communities. The diversity of flora in this area was good enough compared to current status. Additionally, the population density was also standard in this ecosystem.

Post Project

After the intervention, the floral diversity lessened for different anthropogenic activities. Present use of pesticides and fishing methods causing harm towards the aquatic flora. Over extraction of floating, rooted or deeply rooted plants; causing threat for the diversity of this floral community. As the river has still water now, we saw abundance of water hyacinth. Phragmites (Nolkhagra), Water Chestnut, Water Caltrop or commonly called Singara (*Trapa natans*) and White Water Lily has been lowered due to cultivation of paddy and the siltation of the beels.

Impact

The interventions for raising crop productivity have a major impact on aquatic flora throughout the project area. Some species has lost its richness and received threats to its survival namely Water Lilly, Makhna, and Chhaila Grass, Nolkhagra became almost extinct. The Following Table 7.3 represents the status of indicator aquatic plant species of the haor and their impacts over the time.

Table 7.3: Status of aquatic flora of the study area

Indicator Species	Pre project	Post project	Causes of status change/ Interventional linkage
Kochuripana	Medium	Abundant	
Shapla	Common	Less	
Makhna	Not grown	Not grown	
Singra	Less	Rare	
Chailla Ghash	Rare	Not available	

7.4 Aquatic Fauna

Pre Project

Singua river project area was rich in aquatic faunal resources. The varied number of fish's species is linked with a complex network of food web in the entire ecosystem. According to the senior respondents, the area was an ideal place for different aquatic fauna. The area was occupied with numerous local and wetland dependent migratory bird species namely Indian Pond Heron, Little Egret, Common Kingfisher, Little Cormorant, different duck species etc. Migratory bird was commonly found at abundant at Kaheterdia, Raua and Padmakuri beel. Water dependant amphibians and reptile species were commonly found in this area.

Post Project

It is evident after field visit that, considering the pre project scenario the number and diversity of aquatic fauna has been decreased over time. The number of birds, amphibians and reptiles all are dropped down gradually for different factors. As per the respondents, now migratory bird species visiting is limited to only two (2) beels of the total project area and the resident aquatic birds are less frequently seen. Current status of bullfrog has increased over time whereas the number of checkered keelback has been decreased due to hunting and death by fishing nets. Snail and oyster are found abundantly in the project area which is a major food source for the ducks.

Source: CEGIS field visit 3rd & 4th November, 2017

Figure 6.3: View of two aquatic fauna ; Left: Checkered Keelback and Right: Snail in the Singua River

Impact

Variation of wetlands and its characters support habitats for various aquatic fauna. Over the time for different anthropogenic causes the number of aquatic fauna reduced remarkably but it is evident that there is no direct connection for such loss with the intervention activities. To increase agricultural production locals use pesticides which are causing death of many aquatic faunal species.

Table 7.4: Aquatic fauna status of the Singua River

Indicator Species	Pre Project	Post Project	Cause of status change	Type of Intervention that caused the change (If Yes)
Indian Bullfrog	Common	Very common at northern part but less in southern part	Landuse change	-
Cricket Frog	Common	Common	-	-
Checkered Keelback	Common	Common	-	-
Eurasian Otter	Rare	Disappeared from southern part, Occasional at northern part	Habitat destruction	-
Migratory bird	Common	Less		-
Egrets/Herons	Common	Less		
Snail/Oyester	Common	Abundant		

7.5 Swamp Forest and Reeds

Pre Project

According to elderly people, for being a river plain, there was no swamp forest or reed land present in the existing project area. Though the haor possessed no swamp forest, but few area of this haor possessed reedbeds. These lands were mainly dominated with tall grasses and attain swamp character whole of the year.

Post Project

There is no swamp forest in the project area and no notable reed land as this is a flood plain. Small cluster of homestead forest type vegetation are present. These forest had grown over time and peoples contribution.

Impact

There is no remarkable impact due to excavation of Singua River. As there were no visible swamp forest or specific reed land, it may be implied that the intervention didn't play any role in the deterioration or improvement of the homestead vegetation.

7.6 Ecosystem Goods and Services

Important ecosystem goods are food, fertilizer, medicine, energy, fiber, construction and craft material. On the other hand, the ecosystem services have been divided into four categories on the basis of their nature of functions and they are provisioning, regulating, supporting and cultural services.

Pre Project

In this stage, the goods and services had not interrupted by any interventions and these are improved naturally. Food, medicinal plants and genetic resources of the flora and fauna are considering the provisioning services in this area had been standard before implementation of the interventions. There were vast Regulating services such as climatic condition was good because of vast coverage of natural vegetation as well as cultivated vegetation on settlement and cropfields. Wetlands were functioning well due to possess its natural characteristics without any intervention.

Post Project

Services have been changed with changing of functionality of wetlands as this area is mostly depending on wetland ecosystems. The provisioning services as well as food production have boosted up in the case of cultivated varieties with growing of food demand for human. But food production from natural vegetation has been decreased day by day due to landuse change for crop cultivation. The regulating services are as usual over the time.

Impact

Ecosystem services have been changed over the time for changes of landuse as well as increase human population. The provisioning services have been changing day by day due to the implementation of interventions throughout the project area. The change implies rice variety changes from local to HYV and the introduction of other vegetation which occupied largely throughout the project area. The regulating services also interrupted via climatic change while wetland function and habitat became worse. The cultural services have also been changed. It practices tourism instead of ecotourism and hampering the aesthetic value of the project area.

8. Socio-economic Conditions

8.1 Introduction

The Singua River had re-excavated in order to improve the drainage system of the river to drain out water after the monsoon. Another objective of the project was to increase the water containing capacity of the river so that farmers can use the water for irrigation during boro cultivation.

This study was conducted to understand the socio-economic condition and social impact due to the re-excavation of the river. The study findings of this project would depict the project impacts (before and after project). The socio–economic scenario was explored to understand people's socio-economic condition in both before and after project condition using both primary and secondary data considering the objectives of the study.

8.2 Location and Population

The Singua River was re-excavated for about 50 km and the project area covered 15545 ha area. The administrative area of the project covers 120 Mouzas of 19 unions of Pakundia (9), Katiadi (3) and Kishoreganj Sadar (7) Upazilas of Kishoreganj District.

The study area has a total estimated population of 237045 at present (2017). Its population was 166921 (Table 8.1) only at the time of construction of this project by BWDB. Based on Bangladesh Population and Housing Census 1981 the number of households, population, population density and sex ratio are captured for presenting the demographic scenario of before intervention period. The Bangladesh Population and Housing Census 2011 data is used for projecting the demographic scenario of after intervention period. The trend is increasing in number in the cases of households, population, and population density over the years. The sex ratio has decreased – the female population decreased compared to their male counterpart.

Table 8.1: Distribution of population and household in the study area

Time	Household	Population	Sex ratio	Density
Pre-Project (1981)	31115	166921	105	961
Post-Project (projected, 2017)	50992	237045	93	1385

Source: Bangladesh Population and Housing Census 1981 & 2011

8.3 Livelihood Status

Pre Project

Agriculture was the prime source of livelihood of the majority (90%) of population. A very few population were involved in livestock rearing and fishery. The farmers depended predominantly on Kharif-I, Kharif-II and Rabi season cropping cycle and the laborers also depended on crop production. Production of crops yielded them their food and cash money. The livestock and fisheries were the secondary sources of income. In addition, other sources of income were non-agricultural labor selling, small business and employment.

Post Project

Agriculture still is the primary source of livelihoods in the study area, it has improved with higher yields and less damage of crops after the re-excavation of the river. According to the local people, most of them (about 85%) are engaged in agriculture. But over the years after project intervention the sources of income also increased. A number of people have emigrated in different countries and working as laborers. Besides, some people engage in jobs, various types of business and other activities. There are a few people who temporarily engage in capture fishing for their livelihoods.

Impact

Agriculture is the main sources of income so far and the agricultural production has increased in the studied area after the re-excavation of the river. The farmers get chance to produce HYV Aman paddy after re-excavation of the river which was not possible before the re-excavation. Income opportunity based on fishing has also been increased in the fisher community.

8.4 Accessibility in Education

Pre Project

Before intervention the literacy rate was 30.06%, where for male it accounts 34.3% and for female 26.7% (BBS, 1981). Data showed that in the study area the male populations were more educated than their female counterpart. Attending rate of male students (20.8%) was higher than that of the female students (9.8%), which was almost same in pre-school and primary level. But attending of students was started reducing from secondary level because of distance of the educational institutions and financial incapability of people. Besides, students faced trouble for going to school due to flooding for 2 to 3 months.

Post Project

At present the literacy rate is 50.7%, where for male it accounts 49.1% and for female 52.1% (BBS, 2012). Data shows that at present, in the study area the female populations are more educated than their male counterpart. The scenario has started to change after the project intervention while they get opportunity to earn more money from the changing agricultural scenario. Moreover, student can easily go to schools as there was no flooding condition after the project intervention.

Impact

Field findings confirm that the secured income opportunity and social awareness for education lead the local people to send their children at school. Furthermore, different government and non-government programs have also played a vital role to improve the educational status of the area.

8.5 Health and Sanitation

Pre Project

In the study area about 64.19% and 32.49% dwelling households use tubewell and dug-well respectively as main source of drinking water. Remaining of the households used to use pond and canal/river water. Taking a bath, cooking and other domestic activities were also performed by using the river/canal and pond water. Before intervention only 11.11% households of the area had safe sanitary toilets and 46.68% of the households had no toilet facilities. Remaining 42.21% of the households had non-sanitary toilets. Data shows that though, the drinking water situation was more or less satisfactory but the sanitation status was not satisfactory at all. Most of the tube wells and toilets went under water during monsoon and flood period, which created scarcity of safe drinking water and infested people of the community with water borne diseases.

Post Project

The drinking water and sanitation situations have been changed in the study area over time. At present about 95.8% of the households are using tubewell as main source of drinking water. A very few households (0.4%) are using tap water which is negligible. Remaining of the households are still using dug-well, pond and canal/river water. Taking a bath, cooking and other domestic activities are still now performed by using the river/canal and pond water. On the other hand, at present 43.4 % the households of the area have safe sanitary toilets whereas 45.2% of the households have no sanitary toilet, they are using non-sanitary toilets. The alarming thing is that still now 11.4% of the households have no toilet facilities. However, after the project intervention drainage and flooding condition has improved and the tubewells and toilets are protected from inundation, which prevents infestation of the water borne diseases.

Impact

The situation was compounded by flash floods and drainage congestion, which was the major threat to health and sanitation. Usually the area became flooded from August to October. Most of the tube wells and toilets went underwater during monsoon and flood period, which created scarcity of drinking water and threatened the health of the community. However, the scenario has changed after implementation of the projects.

8.6 Land Price

Pre Project

Price of lands varies by its types (low, medium high and high etc.), productivity and connectivity with road. There are five types of agricultural land (high, medium high, medium low, low and very low) in the study area. About 6671 ha of area are high and 2814 ha of area are low. The low land was affected due to the flooding and drainage congestion. For this, the price of this land was minimal and people were not interested to buy low land. It is reported by local people that the price of agricultural land was BDT12,000 to 15,000 per ha.

Post Project

With the project-induced change and autonomous development in the entire study area the land price has been increased over time. After the project intervention, the land price has been increased due to the increased productivity of land and improved communication system. Though exogenous factors like macroeconomic development and inflation have contributed to raise the land price, people's interest to buy land is acknowledged to be one of the reasons of rise in land price. After the project intervention, the price of the previously affected agricultural land per ha is around BDT 30000 to 35000.

Impact

Improved drainage and flooding condition is enabling environment for HYV rice culture. Value of land has appreciated by more than three to four times compared to the pre-project price. On an average about BDT 20 thousand per/ha has been increased for of the previously affected agricultural lands has been increased.

8.7 Agriculture based Income

Pre Project

Livelihood opportunities for households in the Singua River project area were limited and highly seasonal, as they were focused predominantly on agricultural labor associated Lt Aman and B. Aman, Lt Aus and local boro rice cropping cycle. Before the project intervention the total cropped area was 18,111 ha. Following table (Table 8.2) shows the agricultural income based on crop production and name of crops. Based on current production rate (ton per ha) agricultural income has been calculated and presented in this table. It is observed that before the project intervention total value of the annually produced crop was BDT 1091.92 million. To calculate the direct financial outcome, the present government procurement rate of each crop has been taken as unit price into consideration.

Table 8.2: Agricultural income based on crop production in pre-project condition

Crop name	Without project production (in ton)	Total price (in million/BDT)
B. Aus	1404.8	27.39
Lt. Aus	1965.6	38.33
B. Aman	4172.52	83.45
Lt. Aman	8476.832	169.54
Local Boro	6529.152	130.58
Jute	3365.76	84.14
Pulses	2354.15	117.71
Potato	23347.2	262.66
Vegetables	17812	178.12
	Total	**1091.92**

Source: Field data, 2017 through FGD, KII, and Informal Interview

Post Project

After project intervention, livelihood opportunities for households in the Singua River project area have changed, as they have focused on HYV Aman, HYV Aus and HYV Boro paddy production. After the project intervention the total cropped area has increased is 21,385 ha The income opportunity based on agriculture has increased; the laborers get additional working opportunity which generates extra income in the wage earning households. The overall cropped area has also been increased due to the project intervention which also increases the net crop production. After the intervention farmers get BDT 1726.69 million anually from their produced crop (Table 8.3).

Table 8.3: Agricultural income based on crop production in post-project condition

Crop name	Without project production (in ton)	Total price (in million/BDT)
Lt. Aman	7099.184	141.98
HYV Aman	15178.72	295.99
Hybrid Boro	3457.888	64.84
HYV Boro	18731.168	365.26
Local Boro	89.712	1.79
Jute	4887.81	122.20
Pulses	1129.22	56.46
Potato	33966.8	382.13
Vegetables	29605	296.05
	Total	**1726.69**

Source: Field data, 2017 through FGD, KII, and Informal Interview

Impact

Total cropped area has been increased by 3,274 ha and additional 44717.49 ton of crops are being produced in the study area due to re-excavation of the river, introduction of HYV Aman, higher yield rate of HYV paddy and early flash flood protection by project interventions. Therefore, the income of agricultural households has increased. Before the project intervention the agricultural production base average income was about BDT 1091.92 million per year while after project income is about BDT 1726.69 million anually. So, annual agricultural production based income increased up to BDT 634.77 during the period of after project condition.

8.8 Income of Agricultural Wage Labor

Pre Project

Before the project intervention the local varieties of paddy were cultivated and there were some jute and Robi crops also cultivated. In that time there was no technological innovation for crop production. It was found that net demand for labor per ha was near about 140 persons for paddy, jute and Robi crops cultivation and a total number of 25.49 lakh man days labor input were needed per year.

Table 8.4: Agricultural labor demand and labor based income

Crops Name	Without project		
	No. of Labor/ha	Total Man Days	Income (BDT/Million)
B. Aus	130	114140	34.242
Lt. Aus	140	152880	45.864
B. Aman	130	311740	93.522
Lt. Aman	150	639600	191.88
Local Boro	160	444160	133.248
Jute	130	227890	68.367
Pulses	70	137900	41.37
Potato	170	258400	77.52
Vegetables	180	262800	78.84
Total/Average	140	**2549510**	764.853

Post Project

With the changed crop variety the labor requirement has increased due to improved cultural practices (transplanting, using fertilizers, pesticides, etc.). From the field investigation and CEGIS' estimation it has observed that on an average a total number of 31.67 lakh man days labour input is needed for the total cropped area annually. For calculating the labor income the present wage rate per day (BDT 300/day) is considered.

Table 8.5: Agricultural labor demand and labor based income (Project level)

Crops Name	Without project		
	No. of Labor/ha	Total Man Days	Income (BDT/Million)
Lt. Aman	140	442120	132.64
HYV Aman	145	723985	217.20
Hybrid Boro	165	113520	34.06
HYV Boro	160	909280	272.78
Local Boro	155	5580	1.67
Jute	128	297216	89.16
Pulses	65	56030	16.81
Potato	165	285945	85.78
Vegetables	175	334250	100.28
Total/Average	144	3167926	950.38

Source: Field data, 2017 through FGD, KII, and Informal Interview

Impact

The working opportunities for agricultural laborers were limited before project condition though the agricultural activities were done manually. After project intervention, people have got enabling environment to grow more paddy during the Aman season and additional 6.18 lakh labor man days are required annually for the present total cropped area which come from the local laborer community. There is direct impact on agricultural wage based income and the laborers have increased their income BDT 185.52 million.

8.9 Transport and Communication

Pre Project

The people of the study area usually used the road networks for their transportation and communication. The river was not used by the local people for any communication purpose before the project intervention. During the monsoon the river water over spilled the river boundary and submerged the rural roads for 2 to 3 months which created problems for free movement of the community people.

Post Project

After the re-excavation of the river local people are able to use the river for communication purpose in small scale. The local people start using of small boats to go to the local markets through the river. Besides, the flooding condition of the area has also improved. Therefore, the rural roads are free from submergence and people are able to the use the roads round the year.

Impact

The village roads are free from submergence and the peoples can use the roads round the year. On the other hand, the river became useable for communication in a small scale.

9. Summary of Impacts

9.1 Summary of Impacts

Indicators	Pre Project	Post Project	Impact
Water Resources			
Flooding	Monsoon flooding was severe before the re-excavation work. The area got inundated and water level was high.	The impact of monsoon flooding has reduced after the re-excavation work. However, gradual increase of sediment on river bed and malfunctioning of Bahadia sluice gate have started increasing the flooding problems over the last 10-12 years.	People living in the project area received benefits of the project for 20-22 years, but they have started facing flooding problems in recent times, mainly after the year 2000 due to lack of maintenance excavation.
Drainage	The water from the river could not drain out because of the low conveyance capacity of the river. Water logging was seen in Mulladi area in the dry season.	The re-excavation improved the water conveyance capacity of the river and no drainage problem was faced for the first 20-22 years. However, drainage problem is being faced over the last 10-12 years, due to encroachment of river and the time consuming operation of Bahadia sluice gate.	The drainage has been impacted due to discontinuation of maintenance excavation as well as intervention of local people in terms of encroaching the river by land filling and for fish culture.
Sedimentation	The depth of the river decreased up to 20 feet due to sedimentation.	The river got back its required depth of 35-40 feet after completion of the re-excavation. The sedimentation has risen the bed level of the river in recent years due to lack of maintenance excavation.	The river came to life immediately after the re-excavation project. But in recent time, sediment has increased and impeding drainage.
Navigation	Use of boat for transportation was never a practice in the Singua River area.	Boats are still not used for transportation purpose.	No impact of re-excavation in terms of navigation.
Land Resources			
Land use(ha)	Gross area:15,545 i) NCA :9476 ii) Others:6,069	Gross area:15,545 i) NCA:9,179 ii) Others:6,366	i) NCA:-297 ii) Others:+297
Land degradation	No	No	No
Agriculture Resources			
Cropping intensity (%)	191	233	+42
Cropped area (ha)	Rice: 11,408 Non Rice: 6,703	Rice:14,558 Non Rice: 6,827	Rice:+3,150 Non Rice: +124
Crop production (ton)	Rice: 22,549 Non Rice: 46,879	Rice: 44,557 Non Rice:69,589	Rice:+22,008 Non Rice: +22,710

Indicators	Pre Project	Post Project	Impact
Crop damage (ton)	Rice: 3,461 Non Rice: 8,798	Rice: 6,500 Non Rice:9,465	Rice:+3,040 Non Rice: +666
Irrigated area (ha)	Rice: 2,776 Non Rice: 2,980	Rice: 6,407 Non Rice: 3,643	Rice:+3,631 Non Rice: +663
Surface water Irrigation availability	Available	Deficit during month of February to March	Deficit
Agro-chemicals use (ton or kiloliter)	Fertilizers: 0 Pesticides: 0	Fertilizers: 7,520 liquid pesticides: 28 Kelo liter, granular/ powder pesticides: 37 ton	Fertilizers: +7,520 liquid pesticides: +28 Kelo liter, granular/ powder pesticides: +37 ton
Livestock Resources			
Livestock population (number)	Cattle:37,780 Goat:22,750 Chicken:15,260 Duck:32,240	Cattle:45,310 Goat:19,090 Chicken:165,110 Duck:33,240	Cattle:+7,530 Goat:-3,660 Chicken:+14,850 Duck:+1000
Fisheries Resources			
Fish habitat area	• Fish habitat was about 1507 ha. • Of which capture 1506 ha, • Culture 1 ha.	• Total fish habitat is 1877 ha. • Of which capture 1827 ha. • Culture 50 ha.	• Overall Increase the fish habitat 370 ha. • Increase the capture fish habitat area 321 ha. • Increase the culture habitat 49 ha.
Fish habitat condition	• Fish habitat condition and water quality was relatively good. • Some area of river (especially deep area) was untouched from fishing for next year recruitment. • Use of pesticides, agrochemicals and fertilizer in crop field was limited.	• Use of pesticides, agrochemicals and fertilizer in crop field are degrading the habitat quality as well as water quality in the river due to incremental use. • Degrading the water quality because of wastages from homestead, market and other sources.	• Incremental use of agrochemicals, pesticides, and fertilizer in crop field that decrease the fish habitat quality and water quality. • Also polluted by wastage from different sources.
Fish Diversity	• About 70 fish species was available in Singua river area.	• Fish species are almost same but changing the abundance of some fish species.	• Abundance of fish species are changing and big species are almost absent.
Fish migration	• Fish migration was smooth and fish move easily from one place to another without any barrier.	• Raising of river bed level by silt and decompose water hyacinth that disturb fish migration. • Disturbed due to increasing of culture practices by occupying the river and floodplain area at Noapara,	• Due to hampering of fish migration and movement, delayed the fish breeding especially the small fishes in some extent.

Indicators	Pre Project	Post Project	Impact
		Banagram village and floodplain area.	
Fish production	• Overall fish production was 151 MT per year. • Of which from capture production was about 150 MT. • From culture production was about 1 MT.	• Total fish production is about 749 MT per year. • Of which from capture production 529 MT. • From culture production about 220 MT.	• Increase of fish production about 598 MT per year. (From Capture – 379 MT and culture – 219 MT).
Fishing Appliances	• Different types of fishing gears namely koi jal, puti jal, khora jal, current jal, jhaki jal, thela jal, ber jal borshi, Gui (trap made by bamboo) was used to catch the fishes. • The mesh size of net was 2 to 3 cm that is fish friendly.	• Fishing gears are almost similar. At present he fishers are using some new net like moshari jal (small mesh size net below 0.1 cm) that damaging the fish fry as well as fish habitat. • Kironmala (round shape trap made by plastic sheet) use to catch Icha catch.	• Decrease the fish richness and destroy the habitat productivity.
Fishers Livelihood	• Fishers' number was limited and mostly the Hindu fishers was involve with fishing. Numbers of Muslim fishers was absent. • Fishers' livelihood was comparatively smooth.	• Increase the professional and part time fishers day by day. • Good numbers of peoples are involved for their livelihood as fish aratder, fish feed retailer, ice producer, fish labor, transport worker etc.	• Different types of people's involvement are increasing in this sector. • Increasing the fishing pressure on river and other water bodies. The real fishers are shifting from their position.
Fisheries Management	• Some river area was (especially deep area) kept as sheltering place that help for next year propagation. • The professional fisher never catch fish by de-watering or any brood fish.	• Fishing has no restriction. But no water area is kept for sheltering place for next year propagation.	• Fish production is decreasing day by day. The professional fishers are vulnerable condition and displacing from their position.
Ecosystem			
Terrestrial flora	Indicator species were common	Indicator species were common or occasional	Insignificant change
Terrestrial fauna	Status was common for most of the indicator species	Status have been changed	Slightly reduction of population of Bengal Fox due to hunting; intervention is not responsible

Indicators	Pre Project	Post Project	Impact
Aquatic flora	Indicator species were common or occasional	Status have been changed over time	Reduced coverage most of the species due to Agricultural expansion, over exploitation and fishing activities
Aquatic fauna	Indicator species were common	Status have changed in few areas	The number of checkered keelback has been decreased due to hunting and death by fishing nets. Snail and oyster are found abundantly in the project area which is a major food source for the ducks, Other wildlife reduced due to hunting agricultural extension and habitat destruction etc
Swamp Forest and Reedland	No swamp forest but existed small coverage of reeds	Reedbed coverage has changed over time	Change coverage of reedbeds due to expansion of cropping intensity
Ecosystem goods and services	Optimum	Reduced	Provisional services has boosted up and regulating and cultural services has reduced
Socio-economic Conditions			
Employment Opportunity	• Total cropped area was 18,111 ha and about 25.49 lakh man days labor inputs were needed.	• Total cropped area is 21,385 ha where about 31.67 lakh man days labor input is needed.	• Additional 6.18 lakh labor man days have been employed due to the change in the crop variety and cropping intensity, which is possible for project intervention.
Agriculture production base income	• The total agricultural production value at current price was BDT1091.92 million annually from the total cropped area.	• The total agricultural production value at current price is BDT 1726.69 million annually from the total cropped area.	• Agricultural production base income has been increased due to the project intervention up to BDT 634.77million annually from the total cropped area.
Agriculture wage based income	• The agricultural wage base average income was about BDT764.853 million.	• The agricultural wage base average income is about BDT 950.38 million.	• Agricultural wage labor income increased up to 185.52 million during

Indicators	Pre Project	Post Project	Impact
			the period of after project condition.
Land Price	• The price of affected agricultural land was BDT 12000 to 15000 per ha.	• The price of affected agricultural land has increased after project intervention at BDT 30000 to 35000 per ha.	• Asset value of land has appreciated for all land owning households, making them more credit worthy for more assets to own.
Accessibility in Educational institution	• Attending of students decreased at secondary level due to distance of the educational institutions and financial incapability also. • Students faced trouble to go to school due to flooding for 2 to 3 months.	• The scenario has started to change after the project intervention, people have opportunity to earn more money from increased crop production. • Student can easily go to schools as there is no flood after the project intervention.	• The secured income earning opportunity and social awareness for education lead the local people to send their children at school. • Percentage of attendance has increased from the post project scenario during the monsoon.
Accessibility in Health institution	• Before the re-excavation of the river, water over spilled and inundated the houses, tubewells, dug-wells and the toilets as well. During this time infestation of water borne diseases were to some extent high.	• After the project intervention drainage and flooding condition has improved and the tubewells and toilets are protected from inundation, which prevents infestation of the water borne diseases.	• The scenario has changed positively after implementation of the projects.

10. Environmental Management Plan

10.1 Management Plan

Impact	Mitigation Measures	Enhancement Measures
Flooding	• Sufficient water conveyance capacity of the river should be ensured. Embankment should be constructed beside the low-lying agricultural land.	
Drainage	• Bahadia sluice gate should be put into operation to drain out the water. People should be made aware not to fill the banks of the river for agricultural purpose and also not to make interventions for fish culture.	
Sedimentation	• The river reach from Shalowadi to Golaghata for a length of 7 km and 6 km reach from Padmakuri to Singua River should be re-excavated to ease the problem of sedimentation.	
Land use(ha)	• Agricultural land graving should be avoided. • Fallow land should be brought under cultivation	-
Decreased cropped area	• Kanda should be utilized for vegetables cultivation. • Hydroponics or floating bed vegetables cultivation should be introduced or strengthened. • Medium high and medium low land should be utilized for short duration and submergence tolerant T Aman (BINA dhan7, BINA dhan 11, BINA dhan12 and BINA dhan 13) cultivation. • Flood tolerant submergence variety (BRRI dhan51, BRRI dhan52 and BRRI dhan79may be tested.	-
Increased crop production	-	• Crop area should be increased by utilization of fallow land. • Short duration high yielding and hybrid varieties should be developed/introduced/strengthened.

Impact	Mitigation Measures	Enhancement Measures
		• Crop damage should be minimized by timely and proper rehabilitationof water control structures like embankment, regulators, drainage sluices etc.
Decreased irrigated area and Availability of irrigation water	• Regular re-excavation/dredging of surrounding rivers has to be ensured in order for retention of irrigation water.	• Re-excavation of existing beels and khals should be ensured for retention of irrigation water. • Irrigation water should be ensured by stopping drainout the beels during early dry seasonfor fish harvesting.
Status of livestock/poultry	-	• Grazing area should be increased by utilizingfallow land. • Awareness build up through training • Marketing facilities should be improved. • Availability of high yielding breed should be ensured.
Increased crop damage	• Re-excavation/dredging of Singua river should be required at mulladi, Kagar char, Kandapadi, Bil Bahar, Angiadi and Saluadi Mouza. • Regular maintenance work is needed on compartmental embankment by BWDB. • Embankment should be developed at river side and repaired during November to December. • Regular dredging of the rivers has to be ensured in order to reduce the intensity of flash flood. • Rehabilitation works should be finished by February • Quality materials should be used for rehabilitation works. • Short duration high yielding or hybrid varieties should be used instead of long duration BRRI dhan29 variety. • Local varieties should be transplanted in the deeper part of the haorarea instead of short height high yielding or hybrid variety.	
Increased use of agro-chemicals	• Farmers should be encouraged to use organic manure to increase soil fertility while avoiding water	

Impact	Mitigation Measures	Enhancement Measures
	contamination and reduce the soil fertility. • Farmers should be encouraged to cultivate leguminous crops to enhance the soil quality. • Farmer should be follow modern agricultural technology like Integrated Pest Management/Integrated Crop Management(IPM/ ICM), Good Agricultural Practices(GAP) etc.	
Decreasing the fish habitat and water quality.	• Fishing by moshari jal (small mesh size 0.1 cm net) should be banded round the year. • Agrochemicals and pesticides and fertilizer should be used as required.	• Optimum use of agrochemical should be ensure through demonstration and monitoring should be conducted by the Department of Agriculture and Extension (DAE) of related upazila. • Fishing by moshari jal should be banded permanently by upazila fisheries officer in coordination by local elites.
Decrease the richness and disappearing of some fishes.	• Moshari jal should be banded round the year. • Fishing by de-watering should be restricted.	• Some deep area of river near Mulladi bridge site should be protected by the local committee (Committee should be form by 7-9 members) to increase the richness of fish species. • Use of sign board and red flags to indicate the protected area. • Awareness development program should be conducted by the committee in monsoon and post monsoon on bad impacts of use of small mesh size net and de-watering. • Monitoring should be conducted to protect the fishing by moshari jal through professional fishers' communities and local elites/leaders by the guidance of related upazila fisheries officer.
Hampering of fish migration	• Water hyacinth should be removed from the river area for smooth migration from river to beel or floodplain or beel to river.	• Removal of water hyacinth from the Singua river after certain interval by the local committee through awareness development.
Increasing the fishing pressure.	• The ID card holder fisher should allow for fishing round the year. (ID card no need for subsistence fishers).	• New ID card should be provided by the UFO to the new fishers through proper judgment by the old ID card holder fishers and local elites to release the fishing pressure.
Increasing of water area.	• Removal of decompose of water hyacinth and silt from	• Awareness development program should be conducted by the committee

Impact	Mitigation Measures	Enhancement Measures
	the Singua river through re-excavation.	to disseminate the knowledge about the importance of wetlands in our daily life.
Slightly reduction of population of terrestrial fauna	• Increase people awareness about wildlife conservation • Initiate Govt. activities for conserve respective amount of natural vegetation and reedland in each haor area	• Initiate plantation programme along the river levees, kandas and other khash lands
Reduced coverage most of the aquatic floral species at haor due to Agricultural expansion, over exploitation and fishing activities are responsible	• Control over harvesting of aquatic resources	
Decrease in aquatic fauna	• Identify the core habitat for the threatened animals and take action to conserve the respective habitats • Facilitate commercial snail culture for meet up the duck feed demand	• Aware local farmers for using optimum doses of fertilizers and insecticides
Provisional services has boosted up and regulating and cultural services has reduced		• Awareness among people should be increased regarding this.
No referable swamp forest in the area.		• Plantation should be well planned in the suitable selection area.
(Livelihood and employment opportunity) New employment opportunity has been created with the increase of agricultural production.	-	• Training would be ensured for the creation of alternative livelihood options. • River must be re-excavated using the local labor if any manual labor is needed.
(Agricultural production based income) Agricultural production based income has increased due to the project intervention.	-	• New variety of crops and its profitable production should be ensured among farmers.
(Agricultural wage based income)	-	• Appropriate training programs should be initiated for farmers to cope up with the changing climate and technology.

Impact	Mitigation Measures	Enhancement Measures
Agricultural wage labor income has increased with project.		
(Land Price) The opportunities for agricultural production increased for which the value of agricultural land is also increasing	-	• Regular operation and maintenance (O&M) where needed should be continued properly to keep the land optimally productive.
(Education and accessibility to educational institution) Percentage of attendance has increased from the post project scenario during the monsoon. Due to lack of proper maintenance, the river has blocked in some areas and local people face problem from inundation of the road networks in some areas.	-	• Regular operation and maintenance (O&M) where needed should be continued properly to keep the roads free from inundation.
(Accessibility to Health and sanitation) Drainage and flooding condition has improved and the tubewells and toilets has protected from inundation, as such infestation of the water borne diseases decreased.	-	• Regular operation and maintenance (O&M) where needed should be continued properly to keep the settlements and their utility facilities including roads free from inundation.

Appendix A: Photo Album

Water Resources

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Focused Group Discussion

Surma River System

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1. Introduction

1.1 General Information

The Surma River system lies in between 24.875017° and 24.879105° north latitude and between 91.874871°and 92.487668° east longitude under Sylhet District. It encompasses Zakiganj, Kanaighat,Beani Bazar, Sylhet Sadar and Golapganj Upazila. The project area covers an area of 38135 ha. The project area in this river system is bounded by the Surma Riverin the North and East, and by the Kushiyara River up to budbari bazar in the south. The hydrology of the project area is influenced by the Barak, Lubha Chara, Surma and Kushiyara River Systems. The combined course of the Surma and the Kushiyara is known as the Barak in India which originates in the hills of Monipur and flows westward through the floodplain in a meandering course before entering Bangladesh border at Amalshid. The joint course bifurcates at Amalshid into the Surma and the Kusiyara. Both the rivers receive several tributaries before rejoining at a point named Razapur under Upazilla Nasirnagar, District: Brahmanbaria. Thereafter, the river is named as the Meghna. The river then flows southwest to meet the combined flows of the Ganges and the Brahmaputra near Chandpur. From south of Chandpur, the combined flow of the three river systems is known as the Lower Meghna, and falls into the Bay of Bengal through a wide estuary. Most of the khals off taking from the Surma and Kushiyara Rivers have either silted up or closed over the years except Jaigirdar Khal, Shikar Moharntiiad Khal and Teli Khal from the Kusliiyara River, and Kakura Khal from the Surma River. There are some beels and haors namely shinkari beel, balai haor, Dhankuri beel in the project area.

1.2 Project Descriptions

Surma River System project is a Flood Control Drainage and Irrigation (FCDI) project. The key objective of the project was to protect the haor area from flash flood to ensure the cultivation of Boro Rice. It was initiated in the year 1973 and was completed in 1985. The water management infrastructures of the Surma River System include the following:

- Embankment: 120 km.
- Regulator: 2 Nos.

1.3 Present Status of the Project Interventions

Major interventions include submergible embankment, some different types of appurtenant hydraulic structures like regulators. It is observed that along majority part of the embankments, the crest level recedes from the design crest level, existing cross-sections receive damage compared to design cross-section and breaches of embankments are found at numerous locations Breaches allow water entrance into the haor areas before harvesting of boro crops is done leading to severe damage to the crops. Moreover, Public cuts have been observed at different locations along the embankments due to lack of boat pass. Both the regulators perform well in Surma River System project.

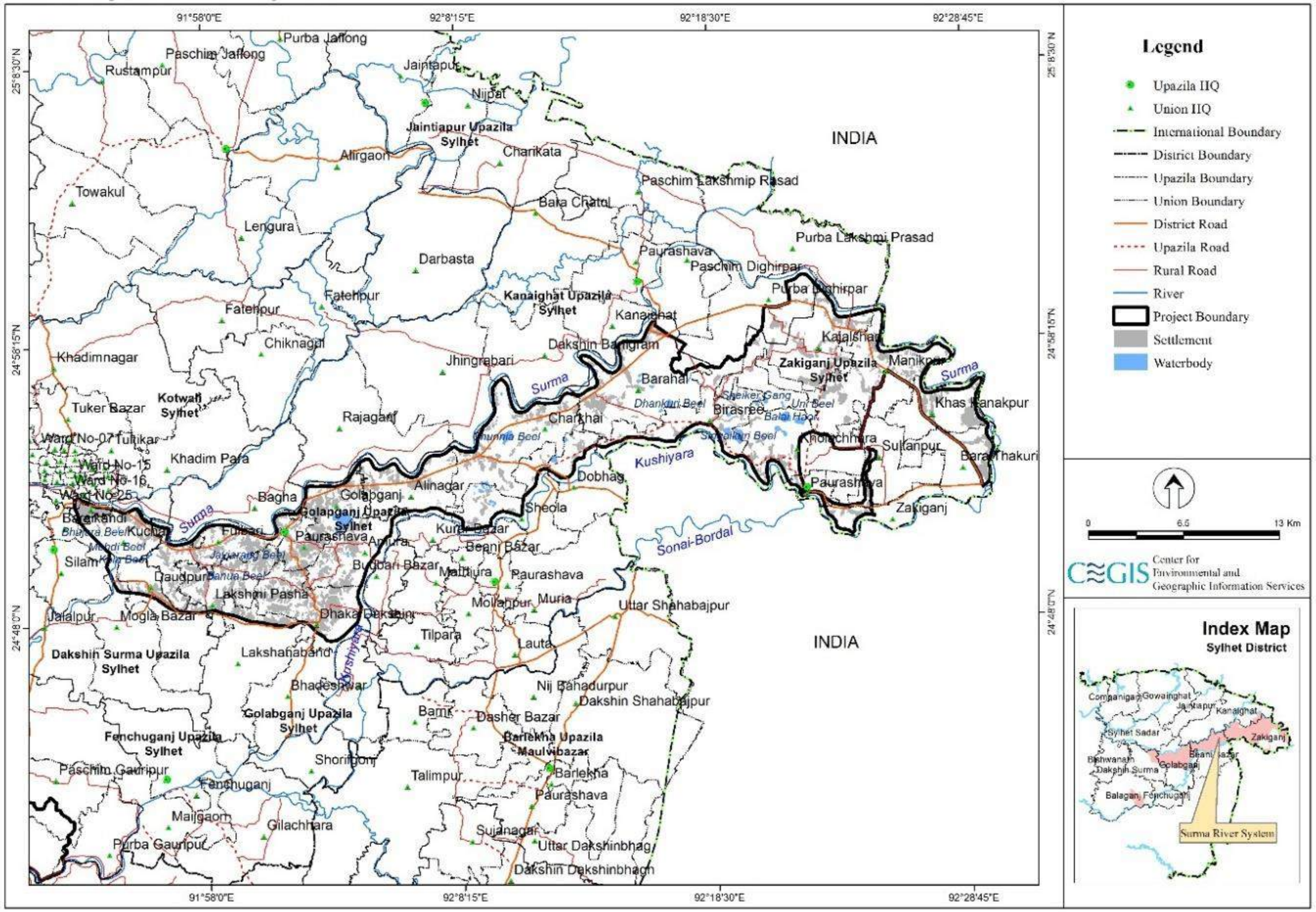

Figure 1.1: Hydrologic features of Surma River System

2. Water Resources

2.1 Flooding

Pre Project

The flash floods due to heavy rainfall in the upstream region during pre-monsoon period mainly flowed through the Surma and Kushiyara rivers and entered in the project area by April. In the full monsoon period, about 70-80% of project area got inundated and water stayed for about 3-4 months.

Post Project

North and eastern portion of project area is protected from the effect of regular flash flood after construction of the embankment along the Surma river. It protects most of the northern region of the project area from being inundated. But some portion of this embankment has been affected due to extreme flood in recent years near zakigonj Upazilla. The embankment along the right bank of the Kushiyara river has also breached at different locations. Erosion and breaching occur along both the Kushiyara and Surma, but is more pronounced along the Kushiyara because of steeper gradient and higher velocity than that of the Surma. As a result, flash flood enters into the project area through the breached points as well as by over topping during severe flash floods and damages crops, homestead vegetation, livestock, and household property.

Impact

The project has delayed the entrance of flash flood by 15-20 days. Flash flood sometimes enters early due to heavy rainfall in the upstream region through the breaching point of embankment due to lack of maintenance work.

2.2 Drainage

Pre Project

There are a number of drainage khals inside the Surma river system, which helped to drain out the flood water as the entire area was open. The local people informed that they cut the embankment for smooth drainage of water when needed and did not face drainage congestion or water logging problem.

Post Project

In post project condition, the flood water cannot flow to the peripheral river easily due to embankment and settlements. As a result, drainage gets delayed which varies at different locations.

Impact

The drainage in the project area has slowed down as well as impeded due to the interventions of the project.

2.3 Sedimentation

Pre Project

Silt and other coarse materials carried by the flash flood during pre-project period got deposited in the rivers as well as in the project area.

Post Project

After construction of embankment and water control structures, the silt and other coarse materials cannot enter into the project area during flash flood, which is mostly deposited in the peripheral rivers. As a result the river bed levels have risen and reduced the conveyance capacity of the rivers and the bed levels of the internal khals have also been silted up resulting in low conveyance capacity of the channels.

Impact

Sedimentation in the Surma and Kushiyara River and internal khals has increased compared to the pre-project condition.

2.4 Navigation

Pre Project

During pre-project period, there was navigational connectivity between the haor and the peripheral rivers throughout the year.

Post Project

Navigational connectivity between the haor and the peripheral rivers mainly remains operative during the monsoon. It does not operate during pre - monsoon period. But, boats can play within the haors and beels for fishing and other purposes. The navigation facility remains operative along the Kushiyara River in most of the places throughout the year.

Impact

The navigational connectivity has been affected due to construction of embankment and water control structures, specially in pre-monsoon season.

3. Land Resources

The project area has fallen in two Agro-ecological zone, namely: Eastern Surma-Kusiyara Floodplain (AEZ-20) and Northern and Eastern Hills (AEZ-29). Non-calcareous grey floodplain soil (non-saline) and grey piedmont soil are the dominant soil. The top soil texture are clay, clay loam and loam; where clay loam texture is dominant. The soils are slow to moderate permeable and have a high or moderate moisture holding capacity. The land type characteristics are not uniform within the project area. About 57% of cultivable areas are medium to high land where maximum flooding depth is below 90 cm during the monsoon period. The recession of surface water from agriculture land starts at first week of October and become free of flood water in end of December.

Two indicators (Land use and Sand carpeting area) have been selected for assessing the impact on land resources due to structural interventions in haor ecosystem. The land use and sand carpeting information under pre-project and existing situations were identified through analysis of the available archived satellite images of CEGIS and it was verified through Focus Group Discussion (FGD) and Key Informant Interview (KII).

Though the project has been completed in 1985, assessment of land use change has been performed on the basis of available LandSAT image of 1989 and 2015 keeping in consideration that land use of 1989 represents the equivalent land use of earlier of project implementation.

3.1 Land Use

Pre Project

The gross area of pre project has been considered as similar to post project. The gross area was 38,135 hectare under pre-project situation of which Net Cultivated Area (NCA) was 26,186 hectare. The rest area were covered with waterbodies (baor, beels, river and khals), forest (herb, shrub and tree) and settlements including homestead vegetation. Details are presented in Table 3.1.

Post Project

The gross area remaining same and the Net Cultivated Area (NCA) is 25,599 hectare. The rest area are covered with waterbodies (baor, beels, river and khals), forest (herb, shrub and tree), and settlements including homestead vegetation. Details are presented in Table 3.1.

Impact

Net cropped area has decreased about 588 hectare. On the other hand, waterbodies, forest and settlement area have increased about 70, 79 and 423 hectare respectively. Detailed impacted area is presented in Table 3.1.

Table 3.1: Detailed land use in Surma River system

Land use	Pre-project Area (hectare)	Post-project Area (hectare)	Impact (Post-project-Pre-project)
Agriculture	26,186	25,599	-588
Waterbodies	930	999	70
Forest	320	399	79
Settlement	10,664	11,086	423
Others	36	52	16
Total	38,135	38,135	0

Sources: Analysis 30 m Resolution Landsat Satellite Images, March: 1989 and 2015

3.2 Land Degradation

No sand carpeting was found before or after implementation of the project.

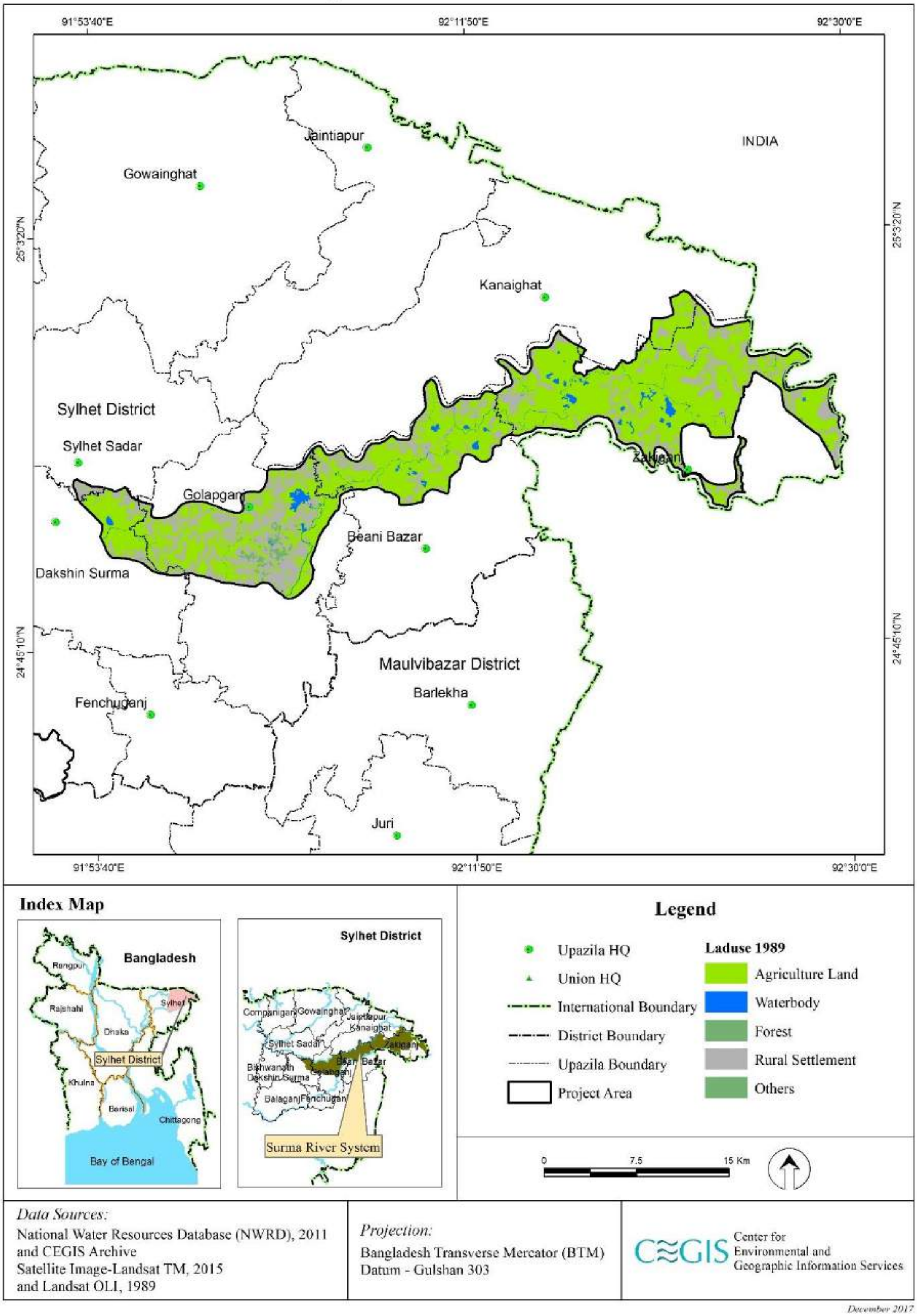

Figure 3.1: Land use of Surma River System (1989)

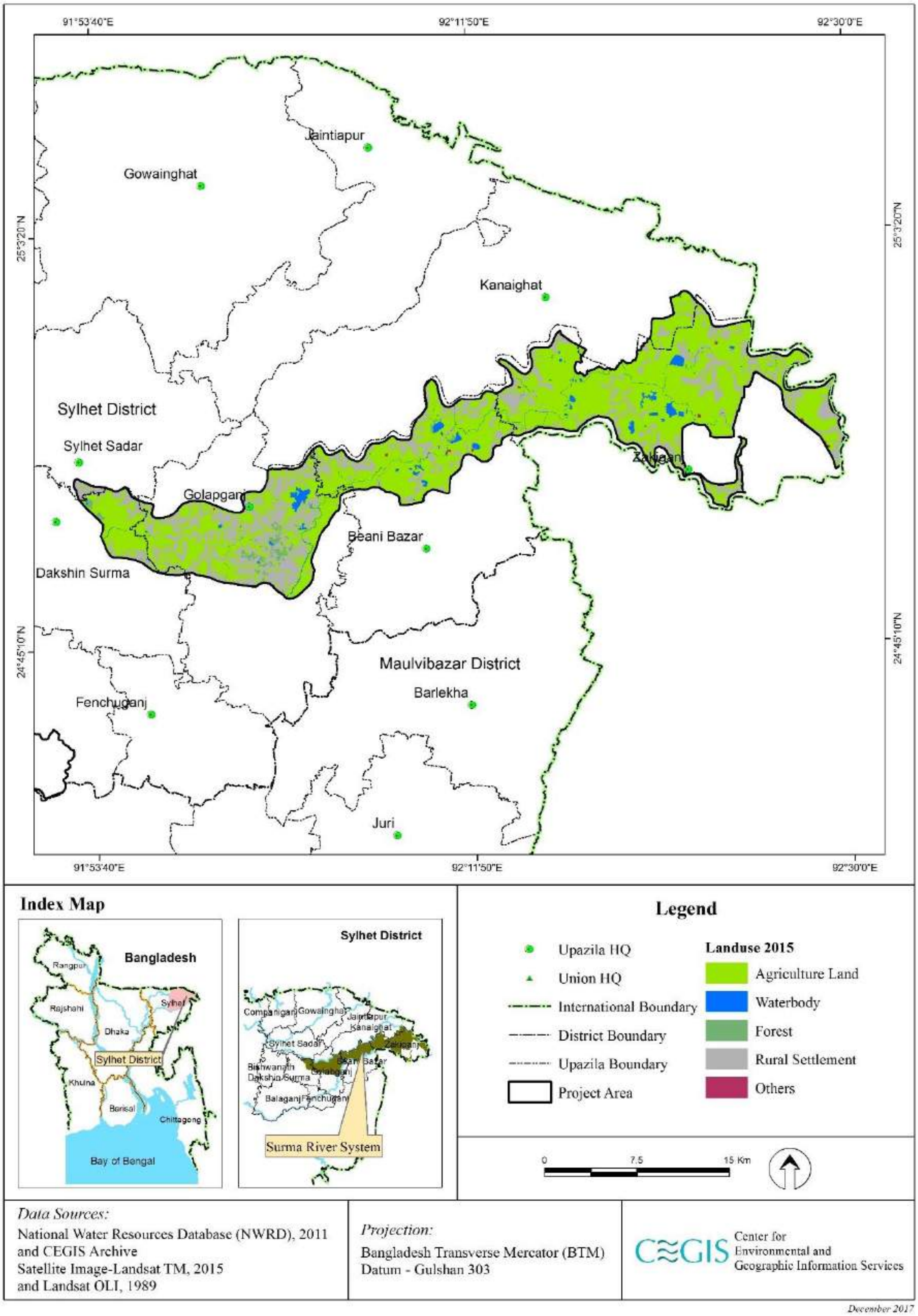

Figure 3.2: Land use of Surma River System (2015)

4. Agriculture Resources

Boro rice is the main crop in Haor areas. In most cases, pre-matured or matured Boro crops are damaged by early flash flood which generally happened due to pre-monsoon heavy rainfall in the hilly areas. Besides, drainage congestion and irrigation water scarcity due to siltation of rivers, Khals and Beels are the another problem for Haor agriculture.

Six indicators (cropping intensity, crop area, crop production, crop damage, irrigation and use of agro-chemicals) have been selected for assessing the impact on agriculture resources due to structural interventions in Haor ecosystem. The information of these indicators were collected from both primary and secondary sources. The primary data were gathered from stakeholders through Focus Group Discussion (FGD) and Key Informant Interview (KII). The secondary data were collected from Bangladesh Bureau of Statistics (BBS) and field level Department of Agricultural Extension (DAE) office. Besides, Boro crop areas under pre and post project situation were identified by analyzing satellite images.

4.1 Cropped Area, Cropping Pattern and Intensity

Pre Project

In pre-project condition, Net Cultivated Area (NCA) was 26,186 hectare, where dominant cropping pattern Fallow-Fallow-Local Boro was found. The land type of this project area was dominated by medium high land (about 52%) followed by low land as presented in Table 4.1

Farmers usually grew local Boro crops in Rabi season. Different varieties of local Boro like Khaiya, Tepi, Shail and Barua were very much popular among the farmers. The total cultivable area was covered with single crop. Therefore, cropping intensity of this area was 100%. Detailed cropping pattern with land type is presented in Table 4.1.

Table 4.1: Pre- project cropping pattern in Surma River system

Land type	Kharif-I (March-June)	Kharif-II (July-October)	Rabi (November-February)	Area (ha)	% of NCA
High Land(F_0)	Fallow	Fallow	Local Boro	1309	5
Medium High Land(F_1)	Fallow	Fallow	Local Boro	13617	52
Medium Low Land(F_2)	Fallow	Fallow	Local Boro	2880	11
Low Land(F_3)	Fallow	Fallow	Local Boro	7856	30
Very Low Land (F_4)	Fallow	Fallow	Local Boro	524	2
			Total	**26186**	**100**

Sources: CEGIS estimation based on field information, October; 2017

Post Project

The project area became protected from early flash flood due to the interventions, which influenced farmers to grow HYV and Hybrid crops. The yields of HYV and Hybrid crops are more than the local varieties. Therefore, cultivated area of local Boro has gradually been decreased and replaced by either HYV or Hybrid Boro. The Net Cropped Area (NCA) has been decreased to 25,599 hectare due to expansion of settlement area. Dominant cropping pattern of the project area is Fallow-Local Aman-HYV Boro which covered by 37% of the NCA. Cropping intensity of this area is 137% which is much below the national average (191%). Detailed cropping pattern with land type is presented in Table 4.2.

Table 4.2: Post- project cropping pattern on Surma River system

Land type	Kharif-I (March-June)	Kharif-II (July-October)	Rabi (November-February)	Area (ha)	% of NCA
High Land (F_0)	Fallow	HYV Aman	Fallow	1280	5
Medium High Land (F_1)	Fallow	Local Aman	HYV Boro	9472	37
Medium High Land (F_1)	Fallow	HYV Aman	Fallow	3840	15
Medium Low Land (F_2)	Fallow	Fallow	HYV Boro	2816	11
Low Land (F_3)	Fallow	Fallow	HYV Boro	5120	20
Low Land(F_3)	Fallow	Fallow	Hybrid Boro	2560	10
Very Low Land (F_4)	Fallow	Fallow	HYV Boro	512	2
			Total	**25599**	**100**

Sources: CEGIS estimation based on field information, October; 2017

Impact

The Net Cropped Area (NCA) has been decreased to 588 hectare but the total cropped area has increased about 8,885 ha. The cultivated area of Local Boro has gradually been replaced by Hybrid Boro/HYV Boro crops due to its higher yield rate and ensured early flash flood protection by project interventions. Impact on cropped area is presented in Table 4.3.

Table 4.3: Impact on cropped area in Surma River system

Crop name	Pre-project Area (ha)	Post-project Area (ha)	Impact Post project- Pre project)
Local Aman	-	9472	9472
HYV Aman	-	5120	5120
HYV Boro	-	17919	17919
Hybrid Boro	-	2560	2560
Local Boro	26186	-	-26186
Total	**26186**	**35071**	**8885**

Sources: CEGIS estimation based on field information, October 2017

4.2 Crop Production

Pre Project

Total cultivated area were covered by Local Boro with yield rate of 3.3 ton/hectare in damage free condition. Considering damaged condition, 2.5 ton/hectare yield was recorded on an average in Local Boro crops. Thus, the total annual crop production of the project area was about 80,129 tons after loss of 6,285 tons. Detailed crop production is presented in Table 4.4.

Table 4.4: Annual crop production of Surma River system under Pre- project situation

Crop name	Total Crop Area(ha)	Damage Free Condition		Damaged Condition		Annual Production (ton)	Production Loss (ton)
		Area (ha)	Yield (ton/ha)	Area (ha)	Yield (ton/ha)		
Local Boro	26,186	18,330	3.3	7,856	2.5	80,129	6,285
Total	**26,186**	**18,330**		**7,856**		**80,129**	**6,285**

Source: CEGIS estimation based on field information, October 2017

Post Project

In post project condition, hydrological regime of the study area is changed. Farmers started to cultivate HYV/Hybrid Boro due to presence of submersible embankment and sluice gate which protect their crops from early flash flood. The yield rates of Local Aman, HYV Aman, HYV Boro and Hybrid Boro is 3.2, 4.0, 5.4 and 6.5 ton/hectare respectively in damage free condition. Hence, total annual crop production is about 149,821 tons after loss of 14,371 tons. Detailed estimation of crop production is presented in Table 4.5.

Table 4.5: Annual crop production of Surma River system under Post- project situation

Crop name	Total crop Area (ha)	Damage free condition		Damaged condition		Annual production (ton)	Production lost (ton)
		Area (ha)	Yield (ton/ha)	Area (ha)	Yield (ton/ha)		
Local Aman	9472	8524	3.2	947	2.5	29,646	663
HYV Aman	5120	4096	4.0	1024	2.8	19,251	1,229
HYV Boro	17919	12544	5.4	5376	3.2	84,938	11,827
Hybrid Boro	2560	2176	6.5	384	4.8	15,987	653
Total	**35071**	**27340**	**-**	**7731**	**-**	149,821	14,371

Source: CEGIS estimation based on field information, October 2017

Impact

Additional 69,692 tons rice is being produced in post project situation. The rice production is increased due to the protection of flash flood which encourages the farmers for practicing high yielding variety instead of local variety. Detailed estimation of impact on crop production is presented in Table 4.6.

Table 4.6: Impact on crop production of Surma River system

Crop Name	Pre- project Production(tons)	Post project Production(tons)	Impact (Post project – Pre- project)
Local Aman	-	29,646	29,646
HYV Aman	-	19,251	19,251
HYV Boro	-	84,938	84,938
Hybrid Boro	-	15,987	15,987
Local Boro	80,129	-	-80,129
Total	80,129	149,821	**69,692**

Source: CEGIS estimation based on field information, October 2017

4.3 Crop Damage

Pre Project

Flash flood was the main cause of crop damage in pre project situation. Before harvesting of Boro crop, water entered into the Haor area and damaged the crops. Total crop damage was 6,285 tons annually. Detailed crop damage is presented in Table 4.4.

Post Project

Surma River system project area is now protected from early flash flood by implementation of project interventions which basically performed well up to 2003. After 2003, flood water enters into the Haor before harvesting of Boro crop (mid-March to early April) due to low height of submersible embankment and malfunctioning of structures. Floodwater coming from the upstream through the Kushiyara River enters the project area through embankment breaches as well as through regulators. The main Khals through which floodwater enters: a) Kakura and b) Mohiluka Khal are located at the upstream part of the northwestern area. As this haor is located relatively downstream in comparison with the haor in Sylhet, flash floods enter the Haor in the 1st week of the month April.

According to local people, Flash floods occur in April and damage standing crops often just before harvesting. In recent years (2017), flood water overtopped and breached the right bank flood protection embankment of the Surma River and some segment of the submersible embankment was damaged severely thereby damaging crops of the haor. The annual crop damaged area was 25% in Local Boro crops but now it is increased 30% and 15% in HYV Boro and Hybrid Boro respectively due to non-functional condition of submersible embankment and regulators as well as siltation of rivers, Khals, and Beels. Most vulnerable mouza's such as Birasree, Barahal, Kuchai, Natessore and Kakura are identified in this respect. Total crop damage is recorded as about 14,371 tons. Detailed crop damage is presented in Table 4.5.

Impact

Crop damage has been increased from 25% to 30%. The amount of crop damage has increased by 8,087 tons. This is happened due to the malfunctioning of the interventions and reduced water carrying as well as retention capacity of surrounding rivers, Khals and Beels. Detailed impact assessment on crop damage is presented in Table 4.7.

Table 4.7: Impact on crop damage in Surma River system

Crop Name	Pre- project Production (tons)	Post Project Production (tons)	Impact (Post project – Pre- project)
Local Aman	-	663	663
HYV Aman	-	1,229	1,229
HYV Boro	-	11,827	11,827
Hybrid Boro	-	653	653
Local Boro	6,285	-	-6,285
Total	6,285	**14,371**	**8,087**

Source: CEGIS estimation based on field information, October 2017

4.4 Irrigation

Pre Project

Before initiation of the project, only surface water was used for irrigating Local Boro crops. The local people normally transplanted this crop immediately after the floodwater recedes and the land is under shallow inundation. Local farmer reported that they stored water with help of bundh/dyke management and irrigated their crop with the help of flooded water in the low lying part of the Haor. They also used traditional modes like *Seuti, Don and Kun* for irrigating their crop from surrounding rivers, Beels and Khals during dry season. Prior to the implementation of the project, irrigation water was more available than the requirement of crops.

Post Project

In post-project condition, the irrigation water demand has been increased due to cultivation of high water demanding HYV Boro instead of Local Boro crop. On the other hand, the availability of surface water is being reduced due to siltation of surrounding rivers, Khals and Beels of the project area. Therefore, the scarcity of irrigation water has been observed from early February to end of March in most of the year. In this time, Surma, Kushiyara and Sheiker Gang rivers are the main source of surface water irrigation. Mainly Low Lift Pumps (LLPs) is being used for lifting surface water instead of traditional mode. T Aman crops is grown under fully rainfed condition.

Impact

There was deficit of irrigation water due to increase of water demand and decrease of water availability during dry season. The irrigation water demand has increased for cultivating high yielding crop variety. On the other hand, surface water irrigation availability has decreased due to siltation of rivers, Khals and Beels of the project area.

4.5 Agro-Chemicals Use

Pre Project

Farmers of the project area cultivated only local Boro crop in pre-project situation. The farmers didn’t apply any chemical fertilizers and pesticides in their local Boro crop. However, some farmers used inorganic fertilizers (mixed grass and rice straw) in their crop field for the enhancement of soil fertility.

Post Project

In post-project condition, Local Boro crop is replaced by HYV Boro crop. Generally more agro-chemicals are required for cultivating HYV and Hybrid crops. So, farmers applied more agro-chemicals for HYV Aman, HYV/Hybrid Boro crop cultivation. Per hectare agro-chemicals use by different crops under post-project situation is presented in Table 4.8.

Table 4.8: Use of agro-chemicals under Post- project situation

Crop name	Fertilizer (Kg/hectare)			Total (kg/ hectare)	Pesticides	
	Urea	TSP	MP		Liq.(ml/ha)	Gran. (Kg/ha)
Local Aman	100	-	-	100	-	-
HYV Aman	125	30	20	175	150	-
HYV Boro	140	40	30	210	200	4
Hybrid Boro	150	50	40	240	250	5

Source: CEGIS estimation based on field information, October 2017

Impact

Additional 6,221 ton chemical fertilizers, 5.0 kilo litre liquid pesticides and 85 tons granular pesticides are being used for crop cultivation annually. Detailed impact on use of agro-chemical is presented in Table 4.9.

Table 4.9: Impact on use of agro-chemicals in Surma River system

Crop name	Pre- project			Post project			Impact		
	Total Fertilizer (ton)	Pesticides		Total Fertilizer (ton)	Pesticides		Total fertilizer (ton)	Pesticides	
		Liquid (Kilo Litre)	Gran. (ton)		Liquid (Kilo Litre)	Gran. (ton)		Liquid (Kilo Litre)	Granular (ton)
Local Aman	-	-	-	947	-	-	947	-	-
HYV Aman	-	-	-	896	0.8	-	896	0.8	-
HYV Boro	-	-	-	3763	3.6	72	3763	3.6	72
Hybrid Boro	-	-	-	614	0.6	13	614	0.6	13
Total	**-**	**-**	**-**	**6221**	5.0	85	**6221**	5.0	85

Source: CEGIS estimation based on field information, October 2017

5. Livestock Resources

Livestock and poultry, being an essential element of integrated farming system, play an important role in the economy of the Haor area. Livestock provides significant draft power for cultivation, threshing and crushing of oil seeds; cow dung as a source of manure and fuel; a ready source of funds; and meat, milk and eggs for human consumption. A large number of livestock are reared in Haor areas but constrained by flash flood causing inundation of large areas during most of the time in the year. This area is famous for duck rearing due to availability of natural feed for ducks in natural large water bodies. All of livestock species suffer much due to shortage of feed, outbreak of waterborne diseases and inadequate shelter facilities. The livestock rearer in the Haor areas do not get fair price due to poor communication as well as lack of marketing facilities.

The indicator status of livestock has been selected for assessing the impact of the project. The status of livestock population data were collected from Livestock Census (1986), Agriculture census (1996 and 2008) of BBS. The status of livestock feed and fodder, diseases, marketing facilities information were gathered from stakeholders through Focus Group Discussion (FGD) and Key Informant Interview (KII).

5.1 Status of Livestock Population, Feed and Diseases

Pre Project

According to livestock census 1996, the livestock and poultry population in the project area were 45,470 cattle, 11,050 goats, 217,150 chicken and 69,560 ducks (Table 5.1). Before implementation of the project, the major feed available to ruminants was mostly crop residues (rice straw) supplemented with weeds from cultivated fields. They are to depend on naturally grown grasses in Kandas and alongside roads and embankments. Most of the year before implementation of the project, the crops were to damage by early flash flood. As a result, shortage of feed from crop residues, reduction of grazing facilities seriously affect livestock rearing. That time, the small holders were to depend on water hyacinth and other aquatic plant for their cattle. The major poultry feeds were rice bran, broken rice, kitchen wastes like rice, rice-gruel, vegetables, fish wastes etc. In addition, the duck usually scavenge in the nearby waterbodies like Haor, Beel, Khal, river or any other low lying areas; mainly eat various types of aquatic insects, small fish, shell or snails. Major livestock and poultry diseases were Gola Fula (Haemorragic Septicemia), Foot and Mouth Diseases (FMD), Pox and Cholera, Duck Cholera, Fowl Pox and Fowl Cholera etc. The most vulnerable period was between July to November for spreading diseases to livestock and poultry populations. Mortality rate of the livestock/poultry was higher due to poor shelter condition and they lived in unhygienic condition. Marketing facilities was not in good condition and price was also low due to less demand of their products and by products. Producer consumed their products at family level and additional products were sold at local village market.

Table 5.1: Status of livestock/poultry in Surma River system

Livestock/ Poultry Category	Pre- project		Post- project		Impact
	No of Households having Livestock	Total No of Livestock	No of Households having Livestock	Total No of Livestock	Number of Livestock Population
Cattle	14,110	45,470	18,490	55,150	9,680
Goat	4,710	11,050	5,600	14,060	3,010
Chicken	28,410	217,150	34,880	221,390	4,240
Duck	15,170	69,560	15,410	75,110	5,550

Source: CEGIS estimation based on agriculture census (1996 and 2008)

Post Project

According to agriculture census 2008, the livestock and poultry population in the project area are 55,150 cattle, 14,060 goats, 221,390 chicken and 75,110 ducks (Table 5.1). In post project condition, crop is protected from early flash flood. As a result, the feed availability of livestock is increased due to increase of crop production. However, some of the year, the crops were damaged by early flash flood. In that year, the small holders were dependant on water hyacinth and other aquatic plant for their cattle. The poultry feeds are same as in pre project situation. On the other hand, more or less similar diseases are found in post project situation. The mortality rate of the livestock/poultry became negligible during the project period, due to extension works at farmers' level such as immunization and insemination program by Department of Livestock (DLS). Marketing facilities during dry season also improved due to improvement of the communication system by constructing the submersible embankments. Therefore, market prices are increased due to high demand of products and by products.

Impact

From 1996 to 2008, about 9,680 cattle, 3,010 goat, 4,240 chicken and 5,550 ducks have increased due to reducing flood vulnerability, improvement of marketing facilities and strengthening of livestock extension services.

6. Fisheries Resources

The Surma River system project is bounded by the Surma River on the North and East, and by the Ku shiyara River up to Budbari Bbazar on the south. This project area is surrounded by an embankment of 60 km which was built by GoB in the year since 1973 to 1985.

The hydrology of the project area is influenced by the Barak, Lubha, Surma and Kushiyara River Systems. The Barak River bifurcates at Amalshid into two rivers one of which is the Surma River and another one is the Kushiyara River. Fisheries resources of the study area comprising of river and Khal having moderately rich and diversified fresh water fish species. At Amalshid Point the Surma River takes an unusual bent, for this reason the source remained dry and loose connectivity with the Barak during dry season. Therefore, dry season nutrient exchange remains suspended between the Barak and the Surma rivers. The lower floodplain land in this area has been developed by the Surma and the Kushiyara rivers. Presently, the floodplain is majorly influenced by the Kushiyara River and floodplain is inclined towards the Kushiyara River.

Most of the Khals drain into the Surma and the Kushiyara rivers have either silted up or closed for a decade. Exceptions are Jaigirdar Khal, Shikar Moharntiiad Khal and Teli Khal from the Kushiyara River, and Kakura Khal from the Surma River. Two regulators have been constructed at the off-take of Rahinipur and Sunam Khals at the Surma River.

There are some Beels and Haor namely Chunia Beel, Shinkari Beel, Balai Haor, Dhankuri Beel, etc. These Beels are mostly used as a source of irrigation water and fish habitat. It may be mentioned here that the fish productions of the Surma and the Kushiyara rivers have not been considered in the production assessment.

6.1 Fish Habitat Area

Pre Project

Fish habitat has been assessed from the landuse data that is extracted from the satellite image of 1989. The estimated total area of fish habitat of the Surma River system was about 11,291 ha where capture fishery was the major contributor. There were some pits having no dike inundated naturally and some ponds with high dike. The ponds without dike are considered under floodplain habitat whereas the ponds with high dike had aquaculture activities. There was a Baor (Oxbow lake), given lease and functioned as a culture fishery. Floodplain shares the major part (about 91%) in the total habitat area followed by Beel, Khal, Baor and fish pond. The breakdown of functionally different fish habitats of this project is given in Table 6.1.

Post Project

The estimated total area of fish habitat is about 12,470 ha. The increment of fish habitat area by about 1,179 ha, which is contributed by Floodplain area of 987, Perennial Beel area of 94 ha, newly created borrow pit area of about 80 ha, and fish pond area of about 25 ha. On the other hand, the decrement of fish habitat area by about 20 ha, which is contributed by the loss of Baor area. The increment of habitat occurs may be due to seasonal Beel converted into floodplain, excavation of drainage channel, newly created borrow pit in the project area and fish pond. The borrow pit is created for the construction of cross-road. The breakdown of functionally different fish habitats of this project and habitat changes is given in Table 6.1.

Table 6.1: Breakdown of fish habitat area by habitat type

Sl. No.	Habitat Category	Habitat Type	Area (Ha)		Impact (Ha) (Habitat Area Change)
			Pre-Project, 1989	Post-Project, 2015	
1	Capture Fishery	Khal	284	297	+13
2		Perennial Beel	549	643	+94
3		Floodplain	10386	11373	+987
4		Borrow Pit	0	80	+80
		Sub-Total =	**11,219**	**12,393**	**1,174**
5	Culture Fishery	Fish Pond	46	26	-20
6		Baor	26	51	25
		Sub-Total =	**72**	**77**	**5**
		Grand Total=	**11,291**	**12,470**	**1,179**

Source: Fish habitat assessment based on field findings and image based landuse data,1989 & 2015.

Impact

The net gain of fish habitat area in the post-project condition is about 1,179 ha, which is modest in compared to Pre-Project condition.

6.2 Habitat Condition

Pre Project

Floodplain was unregulated; timely entry of water into the project area; silt carried by the rivers was dispersed over the project area uniformly; river conveyance capacity was more. Local people opined that the Beels retained water in the dry season at a depth suitable for fishery. Among the Chunia Beel and Thankuri Beel had average depths ranges from about 2.5-3.5 m during dry season. Some of the Beels, such as Jayiarang Beel, Chunnia Beel, Shaiker Gang, Uni Beel, Balai Beel, Singaikuri Beel etc. were shallow and dried up by bailing out of water in the month of December-January for harvesting fish.

Aquatic ecosystem was maintained with the exchange of pre-monsoon nutrients between river and Beel; new water breeding stimulation to the small indigenous species (SIS) of fish; higher breeding success; less natural and fishing mortality; rich biodiversity; more sustainable fish production, etc.

Post Project

Floodplain near the Surma River is regulated but floodwater enters into the project area in the late pre-monsoon from the Kushiyara River through connecting channels and Khals; silt deposited on the river bed as dispersion of silt is hindered or restricted by the submergible embankment along the Kushiyara River; decreased river conveyance capacity. Local people opined that some of the Beels retained water in the dry season at a depth less suitable for fishery. Among the Chunia Beel, Shaiker Gang Beel, Thankuri Beel average depth ranges from about 1.0-2.0 m during dry season. This is happened may be due to wash out of loose soil of agriculture land and silt carrying during flash flood. Some of the Beels, such as Jayiarang Beel, Uni Beel, Balai Beel, Singaikuri Beel are shallow and dry up by bailing out of water in the month of December-January for harvesting fish.

Impact

The net physical condition of habitat is moderately degraded and corresponding provisioning services of the ecosystem including fish. However, the changes in habitat suitability condition of Khals and Beels in terms of quality occurred more due to urbanization , unconventional Beel fishery, illegal fishing (use of chemical fertilizer), extensive use of agrochemicals and pesticides in paddy field, etc. rather than water centric interventions.

6.3 Fish Migration

Pre Project

Previously, the project area was hydrologically linked with the Surma River and the Kushiyara River. For this reason, the abundance of large fishes like Rui (*Labeo rohita*), Catla (*Catla catla*), Ayer (*Aorichthyes aor*), Chital (*Chitala chitala*), Nanid (*Labeo nandina*), etc. were more. Local fishers stated that the lateral fish migration was open through the natural connectivity during pre-monsoon. Furthermore, most of the fries of riverine fishes enter the Beels and floodplain along with flood water. However, successful lateral migration of different fishes, e.g. riverine carps, catfishes, etc. at their certain stages of lifecycle for food and residence is happening due to sufficient depths of the Beels.

Post Project

Pre-monsoon (15 April – 15 May) spawning/breeding migration of riverine and Beel residence SIS fishes is mostly impeded through different connecting Khals due to water regulatory structures and embankment cum road near the Surma River. Besides, riverine fishes migrate laterally to the Beels by overtopping or breaching of the existing submergible embankment along the Kushiyara River during flooding months of Jaisthya-Ashar (15 May–30June).

Impact

Comparing pre and post-project conditions, it can be concluded that migration of SIS is impeded during the pre-monsoon in post-project condition and comprehensible impact has not been observed on fish migration in response to submersible embankment.

6.4 Fish Diversity

Pre Project

This project area was rich in fish biodiversity containing about 120 species (Table-A1 of Appendix-A) in the pre project condition as some of the Beels are perennial and retained water at higher depths mentioned above suitable for fishery. The fish diversity particularly SIS was also facilitated by the unregulated lateral migration from river to Beel and Beel to river during pre-monsoon breeding season. Thus Beel resident fishes (particularly 'SIS' of fish) were dominant in the Beels and floodplain. Moreover, the abundance of large-sized adult fish species (Rui- *Labeo rohita*, Catla- *Catla catla*, Boal- *Wallago attu, Ayre- Mystus aor,* Chital- *Notopterus chitala,* Shol- *Channa striatus, Gojar- Channa marulius,* Pabda- *Ompok pabda,* Shar Punti- *Puntius sarana, etc.)* were also more. Furthermore, species were evenly distributed in the whole project area.

Post Project

Fish species diversity has the declining trend in the Post Intervention condition. This is happening may be due to construction of water control structures, full flood embankment along the Surma River. The factors include habitat loss (both depth and area) due to siltation for heavy rainfall (hilly region), flash flood, urbanization, water pollution, over exploitation of fish due to increase of fishers and modernization of fishing technology, indiscriminate fishing e.g. use of harmful fishing appliances, catching of post larvae and brood fish etc. In consequence of the above phenomena, following fish species become locally unavailable (for last 5-10 years) or have become rare includes Pabda, Shar Puti, Chital, Ayr, Nanid, Rui, Catla, etc.

Local people reported that river's fishes like Kajur Pabda (*Ailia punctata*), Garua (*Clupisoma garua*), Ghonia *(Labeo gonius)* Lasso/Bata (*Labeo ariza*), etc. are not found in Khals and Beels in this area due to lack of connectivity with river for construction of closures on the different Khals and water control structures.

Impact

It can be concluded that changes in fish species diversity and composition are comprehensible in response to Project Intervention comparing pre and post project condition. On the other hand, anthropogenic factors mentioned above may another reason to changes in species diversity and composition.

6.5 Fish Production Assessment

Pre Project

The estimated total fish production was 1,251 metric ton (MT) in 1989 where floodplain shared the most about 60% followed by Beel, fish pond, Baor and Khal as presented in Table 6.2.

Post Project

The estimated total fish production is about 5,027 metric ton (MT) in 2015 where Floodplain shared the most about 81% followed by Beel, fish pond, Borrow pit, Baor, Khal as presented in Table 6.2. In the production assessment, the productivity of the corresponding year has been used.

Impact

Net increase in fish production in post-project condition is about 3,775 metric ton. As a whole, fish production has been increased by about 302%, whereas the Floodplain production by about 388%, Beel by about 320%, Borrow pit by 160%, and fish pond by about 96% (Table 6.2). Such huge increment in productivity may be caused due to adoption of fisheries management like Beel fishery, Beel nursery, increasing fishing activities, fishing commercialization, stocking of culture fish species in Beel fishery, etc. Moreover, the newly created habitats like borrow pit, fish pond have added 200 metric ton of fish respectively. The breakdown of fish productions is presented in the following Table 6.2 by functional unit of fish habitats.

Table 6.2: Breakdown of fish production by functional habitat

Sl. No.	Habitat Category	Habitat Type	Production (MT)		Impact (MT) (Production Change)
			Pre-Project, 1989	Post-Project, 2015	
1	Capture Fishery	Khal	50	61	11
2		Perennial Beel	226	588	362
3		Floodplain	831	4060	3229
4		Borrow Pit	-	120	120
		Sub-Total =	**1,107**	**4,829**	**3,722**
5	Culture Fishery	Fish Pond	61	34	-27
6		Baor	83	163	80
		Sub-Total =	**144**	**197**	**53**
		Grand Total=	**1,251**	**5,027**	**3,775**

Source: Source: Fish production assessment based on field findings and FRSS data, 1989 & 2015.

Impact

The project is almost fully functional and possesses water control structures. For this reason, more deviation in fishing activities is found in response to Project intervention. Fisheries diversity is decreasing day by day due to impeding of fish migration from the Surma River to project area through connecting Khals. Fishing pressure is increased with the increasing of fish demand and fish supply chain for both the local and national fish market.

6.6 Fishers Livelihood

Pre Project

In the project area, about 5% of population was engaged in fishing and activities involved in fish supply chain for carrying out their livelihoods. Out of which about 2% were commercial fishers and the rest of them were subsistence level fishers. Commercial fishers spent annually about 200 days (8-10 hrs/day) in fishing.

Post Project

Presently, about 10% of population are engaged in fishing activities out of which only 1% is commercial fishers. The number of fishers especially subsistence fishers are increasing day by day due to demand of open water fisheries as well as increasing of market price. But rate of increasing of subsistence fishers is very slow because the project area mostly cover urban and semi-urban area and the economic condition of the local people is comparatively good. It may be mentioned here that about 20% households of Alampur, Sharpin and Muglaibagir villages of the project are involved in fishing. They mainly catch fish in the open water area in and around the Surma River for carrying out their livelihoods. The commercial and subsistence level fishers spend annually about 240 days (12-15 hrs/day) and 180 days (3-4) hrs/day) respectively in fishing.

Impact

It can be concluded that the number of part-time and subsistence fishers are increased in response to the project interventions.

6.7 Fisheries Management

Pre Project

Beel fisheries with leasing system were the prominent fisheries management as reported from the local people. All Beels were harvested in the months of February and March. Beel fishery was more sustainable. However, there was no community based fisheries management in the Perennial Beels.

Post Project

Beel fisheries with leasing system are also the prominent fisheries management in the With Intervention condition. Leased Beel only Chunia Beel is harvested annually. Seasonal Beel is used to dry up for catching benthic fish species. However, this type of fishing depends on the leasing rotation system of the Government. There is a number of fisheries associations is a community based fisheries management in the perennial Beels. There is no enforcement for limiting or controlling indiscriminate fishing at the water control structures.

Impact

Rotation length of time for fishing in the leased Beel is one-year rotation. Such over exploitation in conjunction with indiscriminate fishing at the water control structures is being happened mostly due to earn more money and driving fishery ecosystem into fragile resources.

7. Ecosystem

The ecological resources of this study area can primarily be divided into two major ecosystems: terrestrial and aquatic ecosystems. Different types of landscapes belong to different types of flora and fauna. Detail of these will be discussed later in their respective sections.

7.1 Terrestrial Flora

Pre Project

Terrestrial floral diversity and coverage was in good condition before the project initiated. Different types of species had been growing here and there. But natural calamity like flash flood causes damage to the terrestrial vegetation throughout the study area. On the other hand, wave actions during the monsoon caused the erosion of the village vegetation grooves and destroyed most of the standing vegetation to the periphery of the home. The dominant and common vegetations were fruit, timber, fuelwood and medicinal plants. The available flora was Coconut, Betel-nut, Albizia and Bamboo clumps. The wave actions had caused severe damaged to these existing vegetations.

Post Project

After implementation of the interventions like embankment and regulators throughout the study area, the interventions have supported the villagers to disperse towards the resources and they shifted throughout the area and planted different types of vegetation. To harvest this terrestrial flora, the protection from interventions has paved the way to collection properly. The current study team has found that the species diversity and population size is good enough to support the villagers. The homesteads, roadsides and crop-fields have diversified species like Mango, Rain Tree, Kodom, Pitali, Koroch, Barun, Acacia, Mahogany, Blackberry, Papaya, Albizia, Dhol Kolmi, Nal Khagra and Ipil-ipil. The submergible roads have dominated with Dhol Kolmi plant which is usually used for protecting the roads from wave action during monsoon. Terrestrial vegetation on the kandas has already disappeared due to human induced over exploitation. In this way, once very common resources now are getting status as uncommon or rare.

Impact

After implementation of the interventions the status of the terrestrial flora has improved but the over exploitation of the resources by the locals it creates heavy pressure on this resources. Detail impact on terrestrial flora is presented in **Table 7.1** below.

Table 7.1: Overall status of terrestrial flora of Surma River System

Indicator Species	Pre Project	Post Project	Cause of status change
Hijol	Common	Uncommon	Agricultural extension
Koroch	Common	Rare	Over exploitation
Barun	Common	Disappeared	Over exploitation
Dhol Kolmi	Common	Very Common	Plantation by local people, get Suitable habitat and soil quality
Nol Khagra	Common	Disappeared	Over exploration and human-induced pressure

7.2 Terrestrial Fauna

Pre Project

In this period, the species diversity as well as population of the terrestrial fauna was good but the lucrative large mammals were in target to hunt. They have been discriminately hunting throughout their habitats. Brahminy Kite, Pallas's Fish Eagle, Vulture, Fishing Cat, Golden Jackal, Common Toad and Indian Bullfrog found common throughout the project area.

Post Project

In the post intervention stage, several species of the existing fauna have gone in the threatened category because land has gained facilities to produce more crops in the once inundated or denuded land. The lands gain shiny status for producing more crops. Once, the kandas/edges of the land were occupied with different swamp forests or reedlands. Currently, opportunity has come to the villagers to cultivate more land include fallow for crops. In this way, the habitats of terrestrial fauna have gone converted into agricultural land. In addition, use of pesticides in the crop field indirectly cause harm to the fauna. The vulture species once was plenty of numbers but medicine especially diclofenac use for the cattle treatment has downed their population. The short of population in the fauna was mainly the reason of interventions that once introduced in this area. Therefore, human induced pressures trigger faunal status from common to uncommon or rare in this Surma River System.

Impact

The abovementioned human induced pressures are responsible for changing existing status in the haor ecosystem which has paved the way of high yielding production of the waste land for the long time. Such practice triggers declining of the fauna population as well as diversity. The once dominant species right now considered as threatened in this area and these are the Pallas's Fish Eagle, Fishing Cat, and Vulture except Golden Jackal. The overall impact on terrestrial fauna is given in **Table 7.2**.

Table 7.2: Intervention impact on terrestrial fauna of the Surma River System

Indicator Species	Pre Project	Post Project	Cause of status change
Pallas's Fish Eagle	Common	Rare	Population density and human-induced pressure
Brahminy Kite	Common	Common	-
Black Kite	Common	Common	-
Vulture	Common	Rare	Habitat loss, Food poisoning
Otter	Common	Rare	Habitat loss
Fishing Cat	Common	Rare	Habitat loss
Bengal Fox	Common	Common	-

7.3 Aquatic Flora

Pre Project

The Surma River System was free of interventions for a long time. The aquatic flora was abundant with Water Lily, Panilong, Keshordam, and Water hyacinth. Additionally, they occupied fallow lands. The natural calamities had great toll to the aquatic vegetation. Wave action had identified as destructive during the monsoon caused havoc to the aquatic vegetation. During this period Makhna (*Euryale ferox*), Singara (*Trapa bispinosa*), Lotus, and Shaluk noted as very abundant species. Moreover, *Azolla* and *Pistia* found common throughout the study area. Aquatic flora was good in diversity as well as population in this haor ecosystem.

Post Project

The haor ecosystem consists of some seasonal and perennial wetlands e.g. Lohajuri, Mehedi, Lula, Kaichna beels etc. occupied with different aquatic vegetation like Water Lily, Water Hyacinth, Lotus, Keshordam etc. They occupied the fallow land or and grazing lands. After implementation of interventions the fallow lands and other lands have been converted into cropland. In this way, the status of the aquatic ecosystem has changed into threatened status. Most of the species received threats of their existence. In the current decades, most of the indicative aquatic species e.g. Singara, and Chailla Grass have gone extinction in this area due to habitat destruction.

Impact

Aquatic flora of this area has been demolished, by the impact of interventions in this project area to boost up production of the crops. The dominant species lost their previous status. A comparative scenario of the aquatic flora is given in **Table 7.3**.

Table 7.3: Status of aquatic flora of the Surma River System

Indicator Species	Pre Project	Post Project	Cause of status change	Type of Intervention that caused the change (If Yes)
Kochuripana	Very Common	Rare	Agricultural extension	-
Shapla	Common	Common	-	-
Singara	Common	Disappeared	Over exploitation	Agricultural extension
Chhaila Grass	Very Common	Disappeared	Over exploitation	Agricultural extension and herbicide use

7.4 Aquatic Fauna

Pre Project

The wetland existence in this area is haor ecosystem which offers resources to the aquatic animal. Previously, the area was out of anthropogenic pressures and for this reason a large number of resident and migratory birds had been visiting in this area as their feeding ground. The species were Little Cormorant, Little Egret, Great Egret, Cattle Egret, Pond Heron, Ferruginous Duck, Gadwall, Northern Pintail, Fulvous Whistling Duck, Common Teal, Gargany, Red-crested Pochard, Common Pochard, Tufted Duck, etc. Other wildlife species were Checkered Keelback, Skipper Frog, Indian Bullfrog, and Eurasian Otter with the status of abundant.

Post Project

The haor wetland is the destination of wild fauna including migratory birds in the sense of feeding ground during winter season. Introduction of interventions to this haor ecosystem provide support to the inhabitants to grow more crops. The practice of growing more crops is diminishing their feeding ground. Similarly, the practice of cultivation produces sound by the equipments especially power tiller. In addition, use of pesticides has declined their population by reducing breeding success. In these ways, the intervention imposed negative impacts to the aquatic fauna in this area.

Impact

Aquatic faunal population and diversity have been reduced due to destruction of habitat for agricultural extension and deteriorate habitat quality for pesticides using. A specific comparative scenario of the interventions is presented below in **Table 7.4**.

Table 7.4: Status of aquatic fauna of the Surma River System

Indicator Species	Pre Project	Post Project	Cause of status change	Type of Intervention that caused the change (If Yes)
Indian Bullfrog	Common	Decreasing	Agricultural extension, pesticide use	Embankment
Fishing Cat	Rare	Disappeared	Habita destruction, hunting	Not applicable
Migratory Birds	Common	Rare	Agricultural extension	Not applicable
Eurasian Otter	Rare	Disappeared	Agricultural extension	Not applicable

7.5 Swamp Forest and Reedland

Pre Project

The kanda, edges of the beels and fallow lands were occupied with swamp forest and reeds along with various herbs and shrubs. These lands were habitats for different wildlife for feeding, nesting and other social interactions. Hijol. Koroch, and Nal were the prime components of these forestlands. In addition, some of the forest peripheries have dominated with Khagra and Murta. The dense swamp forest provided core habitats to the wildlife in supporting breeding and parental care to their offspring. The overall statuses of the swamp and reed forests were suitable to support wildlife for the long time.

Post Project

Once the dominant swamp forests and reedlands now disappeared due to introduction of interventions throughout the study area. The current practice of cultivation within the protected haor area is conversion of swamp forest and reedlands into cultivable land. Though these lands were once occupied with such vegetations. In addition, collection of firewood by the locals has denuded the forested area.

Impact

By the process of conversion forestland into cultivable land it makes the ecosystem very threatened to sustain. There is no viable wildlife population to be succeeded for the long time. Therefore, introduction of interventions have impacts negative to the swamp forests and reedlands.

7.6 Ecosystem Goods and Services

Pre Project

The terms ecosystem goods are food, medicine, energy, fiber, construction and craft material; services are provisioning, regulating, supporting and cultural services. The goods and services had not interrupted by any interventions and they progress naturally because no interventions were incurred. The *provisioning services* in this area considered as food, medicinal plants and genetic resources of the flora and fauna that had been optimum before implementation of the interventions. *Regulating services* such as climatic condition were good because of vast coverage of natural vegetation. Wetland function was good due to absent of different types of physical structures. *Supporting services* like habitat for species and maintenance of genetic diversity. All migratory species depend upon different ecosystems during their movement. Some habitats have an exceptionally high number of species which makes them more genetically diverse than others and are known as biodiversity hotspots. In such way, the wetland was functioning as its supporting service as a part of ecosystem services. The *cultural services* like spiritual, religious, and recreational and ecotourism, aesthetic, educational and cultural heritage had also been considered standard.

Post Project

The *provisioning services***,** it has been changing day by day due to the implementation of interventions throughout the haor area. The change implies rice variety changes from local to HYV as high productivity of food. The *regulating services* also interrupted via climatic change while wetland function and habitat became worsen. It breaks *supporting services* of ecosystem that has been paralyzed in this haor area. The *cultural services* have also been hampered. Practicing of tourism instead of ecotourism is going on which demolishing the aesthetic value of the haor area.

Impact

The current practice has been changing the ecosystem services negatively specifically in food, medicine, genetic diversity, and population of flora and fauna. Similarly, unplanned tourism establishment, also an event, occurs within the haor ecosystem.

8. Socio-economic Conditions

8.1 Introduction

Haors, with their unique hydro-ecological characteristics, are large bowl-shaped floodplain depressions located in the north-eastern region of Bangladesh. The haor system provides a wide range of economic and non-economic benefits to the local people as well as to the country as a whole. The benefits are accruing from production of rice and fish; rearing of cattle, buffalo and duck; and collection of reeds, grasses and other aquatic plants. Current study has conducted at Surma River system covering several upazilas of Sylhet. The Surma and Kushiyara Rivers, in association with other minor hilly streams, take flows from the Barak, Meghalaya and Tripura River Systems having a dense drainage networks and fall in the haors. The rivers are primarily responsible for providing inputs - rainwater and sediment load to the plains including haors. The plains remain flooded for about 7 to 8 months in a year. This hydrological scenario has been guiding the socioeconomic realities of the haor population. This section explores the socioeconomic conditions of Surma haor population both pre and post project condition, using primary and secondary data and information collected in relation to the objectives of the study.

8.2 Location and Population

This study has been conducted in Surma RIver system which covered Sylhet sadar, Kanaighat, Zakiganj, Beanibazar and Golapganj upazilas under the Sylhet district. In Zakiganj upazila, there are 102 Mouzas in 9 Unions under Zakiganj Upazila. 14 Mouzas in 2 unions under Kanaighat upazila and as many as 134 Mouzas in 13 Unions under Beanibazar, Golapganj and Sylhet sadar upazilas. Following **Table 8.1** shows the union wise population of this study area, based on Bangladesh Population and Housing Census 1991, 2011 and the projected population for 2017.

The population and housing census data 1991 shows the number of population in pre-project condition. The population and housing census data 2011 and projected population data for 2017 depict the demographic condition of the study area in post project condition.

Table 8.1: Union wise population of the study area

<table>
<tr><th>District Name</th><th>Upazila Name</th><th>Union Name</th><th>Total Union-wise Population in 1991</th><th>Total Union-wise Population in 2011</th><th>Projected Aggregated Population at Project Level in 2017</th></tr>
<tr><td rowspan="8">Sylhet</td><td rowspan="4">Beanibazar</td><td>Charkhai Union</td><td>20968</td><td>30575</td><td rowspan="8">671926</td></tr>
<tr><td>Dobhag Union</td><td>16045</td><td>22203</td></tr>
<tr><td>Sheola Union</td><td>14918</td><td>19786</td></tr>
<tr><td>Alinagar Union</td><td>16507</td><td>21429</td></tr>
<tr><td rowspan="2">Kanaighat</td><td>Purba Dighirpar Union</td><td>13490</td><td>22428</td></tr>
<tr><td>Dakshin Banigram Union</td><td>21359</td><td>29486</td></tr>
<tr><td rowspan="2">Sylhet Sadar</td><td>Khadimnagar Union</td><td>31669</td><td>56460</td></tr>
<tr><td>Kuchai Union</td><td>22381</td><td>19165</td></tr>
</table>

District Name	Upazila Name	Union Name	Total Union-wise Population in 1991	Total Union-wise Population in 2011	Projected Aggregated Population at Project Level in 2017
		Mogalgaon Union	19905	30550	
		Daudpur Union	18512	26345	
	Golapganj	Bagha Union	24694	33951	
		Golapganj Union	26990	16364	
		Amura Union	12334	17990	
		Fulbari Union	23728	27876	
		Lakshmi Pasha Union	19949	23901	
	Zakiganj	Kajalshar Union l	18566	27184	
		Manikpur Union	22663	32557	
		Barahal Union	23914	33127	
		Birasree Union	18477	24541	
		Kholachhara Union	18595	20759	
		Sultanpur Union	19280	26062	
		Zakiganj Union	20326	14599	
		Kashkanakpur Union	14825	18625	
		Bara Thakuri Union	17392	23285	
Total Population			458975	619248	

Source: Bangladesh Population and Housing Census 1991 & 2011 and CEGIS estimation, 2017.

8.3 Livelihood Status

Pre Project

Majority people were engaged in agriculture and this was the prime source of livelihood in the study area. They are focused predominantly on agricultural labour associated with the single annual rice cropping cycle. Production of crops yielded their source of food and cash money. The livestock and fisheries were the secondary source of income. In addition, other sources of income were non-agricultural labor, and small business.

Post Project

Agriculture still is the primary source of livelihoods in the study area but its overall production dimension has improved with higher yields and less damage to crops. According to the local people, most of the population (about 80%) is engaged in agriculture. There are lots of migrated people from this area working in different countries mostly as labour. Besides, some people are engaged in jobs, various types of business and other activities. There are few people temporarily engaged in fishing as their livelihood. Because, open fishing opportunity has been reduced due to less movement of fish into embanked area even after submergence and open fishing is also restricted in some leased haor areas. Besides, wetland area has been reduced day by day due to urbanization and industrialization. The livelihood opportunity for wage labour has, more or less, increased in agriculture sector due to more intensity and diversification of crops.

Impact

Agriculture is the main sources of income so far and the agricultural production is increasing in Surma river system area. Income opportunity based on fishing has declined for open fishers and people are being engaged in non-farm economic activities.

8.4 Accessibility in Education and Health

Pre Project

The health and education services for the people of Surma river system were not easily accessible to all. The road communication was not good, particularly during the rainy season. Most of the people used to go to their destination by foot as the road communication system was not satisfactory. On the other hand, students living in distant areas frequently dropped their classes due to unsafe communication during monsoon. Besides, the flood- induced poverty increased the number of drop-out students in this haor area.

Post Project

Number of health and educational institutions have increased over the time, and sick and general people, especially school going children, have become enthusiastic to go to schools run under different Govt. and NGOs programs. Surma haor system area is well connected by road with the district headquarter. Besides, local people, school going children, patient, pedestrian, women and other people have been using roads and some submergible embankments in the dry season.

Impact

Due to good road communication boat is less important mode of transportation in this haor area. Most of the people uses CNG, Auto Rickshaw, Bus as their mode of transportation to go desired places. Patients on emergency can be taken to the Health Clinics by ambulance and local microbus using the road in both dry and wet seasons. The affordability of small and medium farm households to avail those services has increased also with their increased agricultural and ancillary income due to protected crops and other resources from damages, as an effect of flood control and drainage infrastructures.

8.5 Land Price

Pre Project

In pre-project condition, the land price of this haor region was low and people were not interested to buy land due to regular incidence of flood and crop damage. It is reported by local people that the price of agricultural land was BDT 20,000 to BDT 50,000 per Keyar[1] and BDT 1 lakh to BDT 2 lakh (Keyar) for homestead land before project.

[1] 1 Keyar = 30 decimals

Post Project

The project-induced change and autonomous development in the whole haor region has changed the situation and the land price has increased over the period of time. Specially, rapid urbanization is the main reason of price hike. Besides, in post project situation, the land price has increased due to the increased productivity of land. Though exogenous factors like macroeconomic development and inflation have contributed to raise the land price, people's interest to buy those lands is acknowledged to be one of the reasons of rise in land price.

Impact

Rapid urbanization, flood protection and enabling environment for HYV rice culture have caused, the value of land to be increased by more than thrice compared to the pre-project price. Presently, the price of agricultural land per Keyar (30 decimals) is around BDT 3 lakh to BDT 4 lakh, whereas, the price of homestead lands learnt as BDT 6 lakh to BDT 9 lakh per Keyar.

8.6 Agriculture Production based Income

Pre Project

Livelihood opportunities for households in Surma haor system project were limited and highly seasonal, as they were focused predominantly on agricultural labour associated with the single annual rice cropping cycle. Fishing was traditionally an important occupation for the people of haor region. The incidences of livestock husbandry as a livelihood activity in the haor region were also prominent as a tertiary source of income before the intervention.

Post Project

In post project condition, the income opportunity based on agriculture has increased and people have got favorable agronomic environment to grow HYV and other Hybrid paddy and recruit local labor generating extra income opportunities for the wage earning households. People who have more land can grow more crop after the project situation.

Following Table 8.2 shows the agricultural income based on land ownership stratum. Based on current production rate (per ha), agricultural income has been calculated and presented in this table. According to this table, the category of landless people did not get opportunity to share the increased income from agriculture in both pre and post project situation. But their wage income increased. Marginal farmer (farmers who own 0.004 – 0.198 ha land) depend on mainly sharecropping of land owned by the others. Marginal farmer category shows a 5% rise in population (30% before and 35% after project). The reason is learnt to be a proliferation in this category entering from small farmer group who sell out land to owners of upper categories due to high cost of agriculture inputs which they cannot afford. Even some of them become landless when they are forced to sell out all of their land for livelihood sustenance. There are some autonomous factors like urbanization, population growth and distribution of property through inheritance playing the major role in the changes of land ownership pattern.

Table 8.2: Agricultural income based on land ownership spectrum in Surma river system

Land Ownership Stratum	Households (%)		Yearly Income (agriculture base) of Owners having average sized land in the stratum	
	Pre-Project	Post-Project	Pre-Project (BDT)	Post-Project (BDT)
Absolute Landless(0 ha)	20	15	-	-
Functional Landless and Marginal farmer (0.004 – 0.198 ha)	30	35	5420	7567
Small farmer (0.202 - 1.008 ha)	20	20	32412	75364
Medium farmer (1.012 – 3.032 ha)	10	15	108292	226698
Large farmer (3.036 ha and above ha)	10	15	162601	227001

Source: Field data, 2017 through FGD, KII, and Informal Interview

The increased income of different land-size groups is an impact of better agriculture due to project interventions. Standard five land size categories have been used and net increase in yield of rice crop due to improved agriculture practice is shown in table below.

Table 8.3: Net increase in agricultural income by category of land owners in Surma river system.

Land Ownership Stratum	Average size of land (ha.)	Increased yield/ha (ton)	Total increased production (ton)	Price/ton (Tk)	Total additional income for the average size (Tk)
Absolute Landless(0 ha)	0	0	0	0	0
Functional Landless and Marginal farmer (0.004 – 0.198 ha)	0.101	2.1	0.2	21400	4539
Small farmer (0.202 - 1.008 ha)	0.605	2.1	1.3	21400	27189
Medium farmer (1.012 – 3.032 ha)	2.022	2.1	4.2	21400	90869
Large farmer (3.036 ha and above ha)	6.518	2.1	13.7	21400	292919

Source: Field data, 2017 through FGD, KII, and Informal Interview

NB: The ceiling size of the large farmer assumed 10 ha. Average land owning size is the median value of the class. Increase in yield/ha is a difference between yield of Local and HYV Boro. Price of Boro paddy /ton is Tk 21400 as per govt. procurement rate.

Impact

In post project condition, people got enabling environment to grow more paddy and recruit local labor, generating extra income opportunities. But flooding and water logging problems still exist. Due to urbanization near haor area, construction of many structures and land filling are further worsening the water logging problem in this haor region. Damage to crops and assets is, however, comparatively low after project interventions. So the income opportunity based on agriculture has increased with the project situation. People who have more land can grow more agriculture production during the project period.

8.7 Income from Agricultural Wage Labor

Pre Project

It was found that net demand for labor per ha was near about 120 (for local Boro) and total labour income BDT 942696000 (Total Production area×Labour per Ha.×Daily Wage rate). Few labour used to come from outside, while local people was the main labour force.

Pre Project

In post project condition, total crop area and its production have increased significantly. Livelihood opportunity for wage labour has also increased in agriculture compared to the situation before. Currently, the demand of agricultural labour is near about 160 (for Hybrid Boro, local Aman and HYV Boro) per ha with an increase of 40 man days than before. The wage income of local labour households has increased with the project. Agricultural wage labor income increased with the project situation.

Impact

The working opportunities for agricultural labor were limited in pre project condition as agricultural activities were conducted mainly manually. In post project condition, people gets enabling environment to grow more paddy by introducing HYV crop varieties with intensive land-use. Therefore, the direct impact on agricultural wage based income for the laborers has increased BDT 7292 lakh.

8.8 Labor and Seasonal Migration

Pre Project

In pre-project condition, people did not get more access to do other works than the agriculture. Only few people from different regions came to join as work force for crop harvesting and fishing labors. The intensity to come during that period was insignificant and availability of required labors within the haor area was adequate to assist their agricultural production. The technological innovation for agricultural production was not significant at that period and all activities related to agricultural production were physical and manual labor based. It was found that net demand for labor per ha was roughly 120 and local people was sufficient for crop processing.

Post Project

In post project condition, as the agricultural production has increased, livelihood opportunity for wage labour has increased too. The net demand for agricultural labor (having with technological innovation) is roughly 160 per ha with a net increase of 40 labour per ha. Opportunity for their livelihoods has enhanced also.

In a cropping season, when the working opportunities are available, wage laborers rarely migrate outside of their habitat and instead in-migration takes place during that time. During last ten years people have been facing regular damage due to flood and water logging, in this way, people who were dependent on agriculture for livelihood were forced to migrate to neighboring districts for better livelihood. During the flash flood, people of this Surma haor system try to find other working opportunity to render labour as motor driver, garment workers, rickshaw puller in Sylhet and Dhaka city areas. Besides, there are lots of people migrated from this area for working as labour in different countries.

Impact

As a result of increased income from wage, relatively poor labour households of Surma haor system have been able to raise their living standard to some extent. Opportunities of wage income for these households from outside areas of the Surma haor system also have increased due to similar developments in agriculture as well as autonomous development. Therefore, the net impact of the project on income and living standard of labour households of the study haor is positive.

8.9 Transport and Communication

Pre Project

In pre-project condition, the communication system was not good in the Surma haor system area. Most of the road were katcha and unfeasible to travel from one place to other. There was no usable road network inside the haor except the raised boundary (*Ayle*) of crop land. In the dry season, people used bicycle or local other indigenous vehicles for transportation. Sometimes people from other haor areas come to this haor on foot.

Post Project

Due to good road communication after the project intervention, boat has become less important mode of transportation in this haor area. Most of the people use CNG, Auto Rickshaw, Bus as their mode of transportation to go to desired places. The road communication have improved and well-connected with upazila and district sadar. People also use submergible embankments as road to go to school, connecting roads, bazaar and health center etc, specially, during dry season.

FIgure 8.1: Submergible roads in the Surma haor system area

Figure 8.2: River bank embankment in the Surma haor system

Impact

The communication has improved over the pre-project situation. The road communications are playing main role in communication across the haor. This has expedited the transportation of goods and harvests too far off places at low cost. Moreover, accessing schools, markets and health clinics has become relatively easier for children, merchandisers and patients along the embankment at least when flood water recedes.

8.10 Institution and Governance

Bangladesh Water Development Board (BWDB) is liable for physical implementation of water sector projects in haor region. The Local Government Engineering Department (LGED) has also small-scale interventions in some areas of haor region. Of late, Department of Bangladesh Haor and Wetland Development (DBHWD) has been created. As apex institutions, these three have been administering all plans and projects in haor region of Bangladesh for flood management and internal communication development within haor.

Pre Project

In pre-project condition, local government institutions (LGIs) like Union Parishad, Upazila or Thana Parishad were mandated to look after haor water resources management and development. Inundation by flood waters was almost a regular phenomenon in haor area. Leasing of *Jalmahals* (water bodies) was the prime activity of those institutions for raising revenue for the government. It was only after BWDB was created that the issues of water development came in.

Post Project

In post project condition, BWDB started to develop and monitor the project activities in Surma haor system. Their role for operation and maintenance was regular with the completion of submergible roads and embankments. Presently, it has been found from the consultation with primary stakeholders that, presence of BWDB along with other institutions are visible only during the period of damage and to monitor the physical condition of those embankments after the flooding condition. According to the local people, the officials from those institutions do not consult with the local people while planning and designing the project for lessening the damage of haors.

Impact

The presence of BWDB and the DBHWD have some institutional impact on the beneficiaries of the haor project. Overseeing the operation and maintenance of the infrastructures as well as annual repairing of submergible embankments is the main function of those institutions. But the condition of physical infrastructures of the haor is reported to be running below the desired level.

9. Summary of Impacts

Table 9.1: Summary of Impacts

Indicators	Pre-project	Post-project	Impact
Water Resources			
Flooding	▪ The project area was inundated frequently by flash flood by April and at times in mid-March.	▪ After construction of the embankment along the Surma and the Kushiyara river, entrance of flash flood into the project area got delayed by 15-20 days.	▪ The project has delayed the entrance of flash flood by 15-20 and helped save lives and properties specially Boro crops.
Drainage	▪ Most of the flood water could smoothly be drained out to the peripheral rivers as the area was totally open. Most of the project area got dried up by September.	▪ Drainage of flood water has been impeded due to interventions. Most of the project area is drained by November.	▪ The overall drainage of the haor has deteriorated a little bit. It got delayed by 30-40 days than the pre-project condition. ▪
Siltation	▪ The sediment carried by the flash flood got deposited both in the rivers and haor area. Hence, sedimentation was not that much problem before implementation of the interventions.	▪ After construction of embankment and water control structures, the silt and other course materials cannot enter into the project area during flash flood, which is mostly deposited in the rivers. ▪ The river bed levels are rising due to rapid siltation which reduces the conveyance capacity of the rivers. Besides, the khals are also being silted up due to delayed drainage.	▪ Sedimentation in the Surma and Kushiyara rivers and khals has increased compared to the pre-project period.
Navigation	▪ There was navigational connectivity between the Haor and the Surma and Kushiyara rivers throughout the year.	▪ Navigational connectivity between the haor and the peripherial rivers remains operative during monsoon. ▪ Boats can move within the internal haors and beels for fishing and other purposes. ▪ There is no public demand for navigational connectivity between the haor and the peripheral rivers as they use road connectivity.	▪ Navigational connectivity between the haor and the peripheral rivers remains operative during the monsoon. Navigation also remains operative in most of the length of the Surma and Kushiyara rivers. ▪ Being hampered in pre-monsoon
Land Resources			
Land use(ha)	▪ Gross area: 38,135	▪ Gross area:38,135	i) NCA: - 588

Indicators	Pre-project	Post-project	Impact
	i) NCA: 26,186 ii) Others:11,949	i) NCA: 25,599 ii) Others:12,536	ii) Others: +588
Land degradation (Sand Carpeting area), ha	NA	NA	NA
Agriculture Resources			
Cropping intensity (%)	▪ 100	▪ 137	▪ +37
Cropped area (ha)	▪ Rice: 26,186 ▪ Non Rice: 0	▪ Rice: 35,071 ▪ Non Rice: 0 ▪	▪ Rice:+8885 ▪ Non Rice: 0 ▪
Crop production (ton)	▪ Rice: 80,129 ▪ Non Rice: 0	▪ Rice: 149,821 ▪ Non Rice: 0 ▪	▪ Rice:+69,692 ▪ Non Rice: 0
Crop damage (ton)	▪ Rice: 6,285 ▪ Non Rice: 0	▪ Rice: 14,371 ▪ Non Rice: 0	▪ Rice:+8,087 ▪ Non Rice: 0
Surface water Irrigation availability	▪ Available	▪ Deficit during month of February to March	▪ Deficit
Agro-chemicals use (ton or kilolitre)	▪ Fertilizers: 0 ▪ Pesticides: 0	▪ Fertilizers: 6,221 ▪ Pesticides: i) Granular: 84 ii) Liquid: 5	▪ Fertilizers: +6,221 ▪ Pesticides: i) Granular: +84 ii) Liquid: +5
Livestock Resources			
Livestock population (number)	▪ Cattle: 45,470 ▪ Goat: 11,050 ▪ Chicken: 217,150 ▪ Duck: 69,560	▪ Cattle: 55,150 ▪ Goat: 14,060 ▪ Chicken: 221,390 ▪ Duck: 75,110	▪ Cattle: +9,680 ▪ Goat: +3,010 ▪ Chicken: +4,240 ▪ Duck: +5,550
Fisheries Resources			
Fish habitat area	• Total fish habitat area- 11,291 ha • Habitat area breakdown: ○ Khal- 284 ha ○ Beel- 549 ha ○ Floodplain- 10,386 ha ○ Fish pond- 26 ha ○ Baor- 46 ha	• Total fish habitat area- 12,470 ha, • Habitat area breakdown: ○ Khal- 297 ha ○ Beel- 643 ha ○ Floodplain- 11,373 ha ○ Borrow Pit- 80 ha ○ Fish Pond-51 ha ○ Baor- 26 ha	• Gained of total fish habitat area by 1,174 ha (seasonal Beel converted into floodplain, newly created borrow pit)
Fish habitat condition	▪ Habitat quality and suitability condition was in favor of fisheries; ▪ Maintained unregulated ecosystem with better provisioning (i.e., fish) and supporting (i.e., fish nursery and breeding grounds) services like sustainable fisheries.	▪ Habitat quality and suitability condition becomes degraded due to urbanization in the project area ▪ ▪ Regulated ecosystem with somewhat degraded and unsuitable habitat condition particularly for Beel resident fishes;	▪ Slightly degraded habitat condition driving towards relatively less sustainable mentioned provisioning and supporting services of the fisheries.

Indicators	Pre-project	Post-project	Impact
		▪ Increased pollution load due to intensified Boro cultivation.	
Fish Diversity	▪ More or less evenly distribution of fish species over the area.	▪ Abundance of some biologically and commercially important fish species become low or rare locally; ▪ Population of column feeders like C. chitala, L. rohita, etc. and bottom feeder fish species like Heteropneus fossilizes, Clarius batrchus, Channa punctatus, Channa marulius etc. become affected more due to dewatering of Beels and indiscriminate fishing in Beel leasing system; ▪ Increased abundance of SIS fish species. ▪ River's fisheries decreased	▪ More imbalance in fish species distribution over the area; ▪ Vulnerability to Beel resident fish species; ▪ Possible inbreeding problem due to increase of culture exotic fish species.
Fish migration	▪ Unregulated lateral fish migration from river to floodplain and floodplain to river through Khal;	▪ The project is almost fully functional. For this reason, fish migration from river to Beel and Beel to river in the pre-monsoon season is being obstructed due to embankment and water control structures.	▪ There is a significant implication of interventions on fish migration particularly for SIS and large fishes.
Fish production	▪ Fish production in 1989 was about 1,251 metric ton.	▪ Fish production in 2015 was about 5,027 metric ton.	▪ Overall fish production gain is about 3,775 metric ton in 2015 compared to production of 1989.
Fishers Livelihood	▪ Commercial fishers were dominant in floodplain fish habitat meaning livelihood fully dependent on fishing. ▪ Fishing people were less.	▪ Part-time fishers become dominant in floodplain fish habitat meaning carrying livelihood with fishing is not adequate and need other income generating activities. ▪ Fishing people are more.	▪ Fishing based livelihood of commercial fishers becomes unsustainable due to dominancy of part-time fishers.
Fisheries Management	▪ Beel fishery maintained three-year rotation in harvesting fish; ▪ Fish got more time for propagation and grow up; ▪ Sustainable fishery.	▪ Beel fishery is being maintained mostly one-year rotation in harvesting fish. ▪ Fish is not getting enough time for propagation and grow up; ▪ Unsustainable fishery.	▪ Beel fishery is not being secured by the project activities
Ecosystem			

Indicators	Pre-project	Post-project	Impact
Terrestrial flora	▪ Indicator species were common	▪ Significant change of coverage	▪ Most of the floral diversity and coverage have changed; intervention is responsible.
Terrestrial fauna	▪ Indicator species were common	▪ Status have changed	▪ Agricultural expansion has reduced population
Aquatic flora	▪ Indicator species were common	▪ Status have changed (-ve) largely	▪ Over exploitation of resources; intervention is indirectly responsible.
Aquatic fauna	▪ Indicator species were common	▪ Status have changed (-ve) greatly	▪ Habitat conversion into cropland; over exploitation of resources; interventions are indirectly responsible.
Swamp forest and Reedland	▪ Indicator species were common	▪ Status have changed (-ve)	▪ Swamp forest and reedland disappeared; intervention is indirectly responsible.
Ecosystem goods and services	▪ Swamp forest and reedland occurred	▪ Swamp forest and reedland disappeared	▪ The forest coverage went vanish due to practice of crop production; intervention is indirectly responsible.
Socio-economic Conditions			
Employment Opportunity	▪ Total cropped area was 26186 ha whereas about 120 man days labour (per ha.) inputs were needed	▪ Total cropped area were 35071 ha where about 160 man days labor per ha. input were needed	▪ Additional employment opportunity has been created due to HYV culture of paddy ▪ New employment opportunity had been created with the increase of agricultural production
Labor and Seasonal Migration	▪ The demand for labor per ha was near about 120 and maximum labor were engaged from the locality.	▪ The demand for agricultural labor is near about 160 per ha.	▪ The net demand for labor has been increased of 40 labour-days per ha. Local wage earning

Indicators	Pre-project	Post-project	Impact
			households within the project have got more livelihood opportunity and their socioeconomic situation has slightly been improved with more wage income.
Agriculture and wage base income	▪ The total agricultural production value at current price was BDT 18618 lakh at project level ▪ The agricultural wage income was about BDT 9427 lakh. at project level	▪ The total agricultural production value at current price after project is BDT 35038 lakh at project level ▪ The agricultural wage income is about BDT 16719 lakh at project level	▪ Agricultural production based income has increased due the project intervention. ▪ Agricultural wage labor income increased upto BDT 7292 lakh during the post project condition.
Land Price	▪ The price of agricultural land was 20,00 BDT to 50,000 BDT per Keyar and that of homestead land was between BDT 1 lakh to 2 lakh per decimal only	▪ The price of agricultural land is near to be 3 lakh to 4 lakh per Keyar whereas the price of BDT 6 lakh to 9 lakh per Keyar for homestead lands.	▪ Asset value of land has increased for all land owning households, making them more credit worthy for more assets to own.
Accessibility to Health and Educational institution	▪ It was tough to go to schools and health institutions due to bad communication system during both wet and dry season.	▪ With the damage of certain locations of the roads and embankments people felt unsecured to use their way of moving during the rainy season. ▪ Sometimes the roads inundated by flood in rainy season. ▪ School going children sometimes fall in problem in using damaged roads as their way to go to schools. ▪ Overall communication system has been improved both the dry and wet season	▪ The communication system rendered people comfortable at least during dry season but frequent breaches have left them uncertain about using damaged roads and embankments in wet season
Institution and Governance	▪ Local Union Parishad used to manage local water resources, while Beels and haors were managed by Deputy Commissioner at district level.	▪ The institutions (i.e. BWDB) constructed embankments and has been conducting O&M of infrastructures ▪ Local people's participation in planning and management of water	▪ Institutional presence (BWDB) is seen but efficiency of flood control system is at the low ebb.

Indicators	Pre-project	Post-project	Impact
		development infrastructures is insufficient and hence governance is ineffective.	▪ In absence of participatory management body within haor, the governance position does not turn out meaningful. ▪
Employment Opportunity	▪ Total cropped area was 26186 ha whereas about 120 man days labour (per ha.) inputs were needed	▪ Total cropped area were 35071 ha where about 160 man days labor per ha. input were needed	▪ Additional employment opportunity has been created due to HYV culture of paddy ▪ New employment opportunity had been created with the increase of agricultural production

10. Environmental Management Plan

Table 10.1: Management Plan

Impact	Mitigation Measures	Enhancement Measures
Flooding	• The Beels, Khals and rivers should be dredged/ re-excavated to increase carrying capacity and thereby reducing the impact of flood. • The breached/damaged portion of the embankment should be repaired as and when required before onset of the pre-monsoon.	
Drainage and Sedimentation	• The rivers and Khals should be dredged/ re-excavated on a need basis. • Sufficient outlets should be constructed at suitable locations along the Kushiyara River for proper drainage	
Land use change	• Agricultural land graving should be avoided. • Fallow land should be brought under cultivation	-
Decreased cropped area	• Raise up the height of the Kushiyara River right bank embankment up to 3 to 4 feet. • Complete the rehabilitation work by the months of December-February. • Kanda should be utilized for vegetables cultivation. • Hydroponics or floating bed vegetables cultivation should be introduced. • Medium high and medium low land should be utilized for short duration and submergence tolerant T Aman (BINA dhan7, BINA dhan 11, BINA dhan12 and BINA dhan 13) cultivation. • Flood tolerant submergence variety (BRRI dhan51, BRRI dhan52 and BRRI dhan79 may be tested.	-

Impact	Mitigation Measures	Enhancement Measures
Increased crop production	-	• Crop area should be increased by utilization of fallow land. • Short duration of high yielding and hybrid varieties should be developed/introduced/strengthened. • Crop damage should be minimized by timely and proper rehabilitation of water control structures like embankment , regulators etc.
Decreased irrigated area and availability of irrigation water	• Regular re-excavation/dredging of Kushiyara River , Sheiker gang and Surma River has to be ensured in order to retention of irrigation water.	• Re-excavation of existing Beels (Jayiarang Beel, Banua Beel, Kola Beel, Mehdi Beel, Chunnia Beel, Dhankuri Beel, Singaikuri Beel, Doba Beel) and Khals (Kakura Khal and Mohiluka Khal) should be ensured for retention of irrigation water. • Irrigation water should be ensured by stopping drain out the Beels during early dry season for fish harvesting.
Status of livestock/poultry	-	• Grazing area should be increased by utilizing fallow land. • Awareness buildup through training • Marketing facilities should be improved. • Availability of high yielding breed should be ensured.
Increased crop damage	• Functioning and maintenance of sluice gates under Rahimapur and Sunam Khals. • Regular dredging of the rivers has to be ensured in order to reduce the intensity of flash flood. • Rehabilitation works should be finished by February • Quality materials should be used for rehabilitation works. • Short duration high yielding or hybrid varieties should be used instead of long duration BRRI dhan29 variety. • Local varieties should be transplanted in the deeper part of the Haor area instead of short height high yielding or hybrid variety.	
Increased use of agro-chemicals	• Farmers should be encouraged to use organic manure to increase soil fertility while avoiding water contamination and reduce the soil fertility.	

Impact	Mitigation Measures	Enhancement Measures
	• Farmers should be encouraged to cultivate leguminous crops to enhance the soil quality. • Farmer should be follow modern agricultural technology like Integrated Pest Management/Integrated Crop Management(IPM/ ICM), Good Agricultural Practices (GAP) etc.	
Gained of total fish habitat area by 1179 ha	• Not applicable	• Re-excavation of internal Khals and channel and seasonal Beels
Moderately degraded fish habitat condition driving towards less sustainable provisioning services majorly fisheries.	• Stop discharging of urban waste water into the Khals and Beels • Water holding capacity in the Khals and in some cases in the Beels (i.e., Jayiarang beel, Uni Beel, Balai Beel, Singaikuri Beel etc.) should be increased through re-excavation/ dredging. • Maintain minimum 1.5 m water depth in almost all water bodies during dry season.	• Not applicable
Vulnerability to Beel resident fish species	• Unconventional fishing appliances (i.e., fine meshed gears, dewatering, etc.) should be banned; • Should motivate and encourage agriculture sector people for abstaining from use of chemical fertilizers and pesticides for keeping water uncontaminated.	• Beel nursery programme with native fish species should be increased; • Build sanctuary with the involvement of adjacent fishers community;
Significant implication of interventions on fish migration.	• Increase the conveyance capacity of Khal maintaining minimum 1m depth during dry season; • Fish friendly structures should be implemented for suitable fish passage. • Fishing should be controlled during pre-monsoon and recession period. • Prepare and follow gate operation plan	• Proper maintenance work should be conducted and monitored by the Project Implementation Committee (PIC). • Monitoring and awareness building activities should be conducted through fishers' communities under the guidance of Upazila Fisheries Officer.

Impact	Mitigation Measures	Enhancement Measures
	• Formation and strengthening of water control structures	
Overall fish production gain is about 3775 metric ton in 2015 compared to production of 1989.	• Not applicable	• Beel fishery should be promoted with three-year rotation; • Beel dewatering should be stopped.
Fishing based livelihood of commercial fishers becomes unsustainable due to dominancy of part-time fishers.	• Fishing ban time income generating activities should be promoted. In that case, the Fisher's community should be involved in water management group.	• Not applicable
Beel fishery is being secured by the scheme though the weak enforcement is not yielding expected benefit.	• The scheme should be maintained with the coordination of the line agencies.	• Not applicable.
Most of the floral diversity and coverage have changed; intervention is responsible.	• Plantation of local species in the project areas (i.e. Settlement ridge, Roadside, Kandas etc.) needs to be done as early as possible. • Tree based farming may established • Use of natural fertilizer is required rather than chemical fertilizer	• Local species should give preference for all types of plantation.
Agricultural expansion has reduced population	• All the khash land with swamp forest and reed lands should be out of public lease and allotments	• Create awareness about wildlife conservation; and • Initiate keeping swamp forests and reedlands to conserve wild fauna.
Over exploitation of resources; intervention is responsible.	▪ Control over harvesting of natural resources	• Create awareness among the masses regarding this issue
Habitat conversion into cropland; over exploitation of resources; interventions are responsible.	• Identify core habitat to the threatened animals and take action to conserve respective habitats; and • Aware local farmers for using optimum doses of pesticides	
Swamp forest and reedland disappeared; intervention is responsible.	• Create swamp forests and reedlands for the conservation of biodiversity.	

Impact	Mitigation Measures	Enhancement Measures
The forest coverage went vanish due to practice of crop production; intervention is responsible.	• Implement plantation on kandas and other khas lands • Ban allotment of khasland and beel leasing	
(Livelihood and employment opportunity) • New employment opportunity had been created with the increase of agricultural production • Employment opportunity has been created during the period of operation and maintenance of those projects in Surma haor system.	-	• Roads and Submergible embankment must be repaired using the local labor • Allocation of all Beel /Jallmohal to the actual fishermen on equity basis • Training would be ensured for the creation of alternative livelihood options • Soft loan would be provided especially in the emergency period (i.e. post flooding condition) • Build up linkage with farmer and national, international traders
(Labor and Seasonal Migration) • The demand for skilled and unskilled labor increased during project construction.	-	• Skill development training program should be initiated for capacity building especially for men and women to enable them to continue with the skill as livelihood opportunity in similar construction works.
(Agriculture and wage based income) • Agricultural production based income increased due the project intervention. • Agricultural wage labor income increased with project.	-	• New variety of crops (flood-risk free) and its profitable production should be ensured among farmers. Appropriate training programs should be initiated for farmers to cope up with the changing climate and technology
(Land Price) • The opportunities for agricultural production increased for which the value of agricultural lands is also increasing	-	• Regular Operation and Maintenance (O&M) and riverbank protection work should be continued properly to keep the land optimally productive.
(Accessibility to Health and Educational institution) • The submergible roads and embankments provided opportunity to	-	• A monitoring Committee should be formed in association with BWDB and local people to identify damaged parts of the embankment • Local participation has to be ensured to repair minor damages to embankment.

Impact	Mitigation Measures	Enhancement Measures
be used as road with project intervention. • Due to lack of proper maintenance, the damage of the embankments was increased and local people started to face problem to use these embankments as their means of communication.		
(Institution and Governance) • There is no mechanism to consider local people's ideas and concerns while drawing project operation and maintenance systems. Project' people suffer crop loss and other household vulnerabilities. • The role of institution to consider public demand in policy, operation and maintenance on the issue of those submergible embankments.	• Formation of Water Management Organizations (WMOs) following the Guidelines for Participatory Water Management (GPWM) • Quarterly Meeting should be initiated with WMG/WMA to understand the gap of institutional policy and governance • Monitoring team should be formed comprising BWDB-WMA to visit submergible embankments periodically • People's feedback should be taken before the implementation of any kind of policy in relation to new project and maintenance and operation of those submergible embankments.	• Roads and Submergible embankment must be repaired using the local labor • Allocation of all Beel /Jallmohal to the actual fishermen on equity basis • Training would be ensured for the creation of alternative livelihood options • Soft loan would be provided especially in the emergency period (i.e. post flooding condition) • Build up linkage with farmer and national, international traders

Appendix A

Table A1: Availability of major fish species in the Surma River System (but not limited)

Sl. No.	Local Name	Scientific Name	IUCN Status, 2015
1	Ayre	*Sperata aor*	VU
2	Baila	*Glossogobius giurus*	LC
3	Bajari Tengra	*Mystus tengara*	LC
4	Barobaim	*Mastacembalus armatus*	EN
5	Boal	*Wallago attu*	VU
6	Catla	*Catlacatla*	LC
7	Chapila	*Gudusia chapra*	VU
8	Chang	*Chana orientalis*	LC
9	Chital	*Chittala chittala*	EN
10	Darkina	*Esomus dandicus*	LC
11	Gojar	*Channa marulius*	EN
12	Gutum	*Lepidocephalichthys guntea*	LC
13	Kabashitengra	*Mystus cabasius*	NT
14	Kaikla	*Xenentodon cancila*	LC
15	Kalibaus	*Labeo calbasu*	LC
16	Kanipabda	*Ompok bimaculus*	EN
17	Kashkhaira	*Chela laubuca*	LC
18	Katari Chela	*Salmostoma bacaila*	LC
19	Kholisa	*Colisa fasciatus*	-
20	Koi	*Anabas testudineus*	LC
21	Kuchia	*Monopterus cuchia*	VU
22	LalChanda	*Chanda ranga*	-
23	Lalkholisa	*Colisa lalius*	-
24	Magur	*Clarias batrachus*	LC
25	Mrigal	*Cirrhinus mrigala*	NT
26	Mola	*Amblyphayngodon mola*	LC
27	Nandil, Nandi, Nandina	*Labeo nandina*	CR
28	Napit koi	*Badis badis*	NT
29	Potka	*Tetradon cutcutia*	LC
30	Rani	*Botia dario*	EN
31	Rui	*Labeo rohita*	LC
32	Shing	*Heteropneus fossilies*	LC
33	Shol	*Channa striatus*	LC
34	Tara baim	*Macrognathus aculatus*	NT
35	Tengra	*Mystus vittatus*	LC
36	Tit puti	*Puntius ticto*	LC
37	Veda/ Mani	*Nandus nandus*	NT
	Etc.		

Appendix B

Water Resources

Agriculture Resources

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Updakhali Haor

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1. Introduction

1.1 General Information

Updakhali Haor Project is located between latitude 24°58'45.87"N and 25°4'35.19"N and between longitude 90°50'49.04"E and 90°58'15.69"E in Netrokona and Sunamganj districts. It has covered two upazilas namely Kalmakanda under Netrokona District and Dharmapasha under Sunamganj District. The entire haor area encompasses. Barokapon Union (60%), Pogla Union (30%) and Kalmakanda Union (8%) under Kalmakanda Upazila and Maddyanagar Union (2%) under Dharmapasha Upazila. The project has a gross area of 8005 ha. It is a flood control and drainage improvement project implemented by BWDB and financed by Government of Bangladesh (GoB).

The Updakhali and Gunai River have met in the east side of the project area near Maddyanagar Bazar. Updakhali has joined with the Bubai River in the north-west corner of the project area. The Bubai and Gumai have also met in the west side of project. The water resources system in this area comprises a number of beels, khals and rivers. The beels stores part of the flood water while the khals drain out the water to the peripheral rivers. The beels inside the haor are of different sizes varying from 2 to 50 acres. The name of the beels are: Moyshaura beel, Goraduba beel, Medabeel, Kandail beel, Gangadubi beel, Nania beel, Jangia beel, Dogra beel, Boalia beel, Shingjani beel, Ranga matia beel, Chapair beel, Naya beel, Chater beel, Bhaijan Beel, Gajariabeel, Rekha beel, Hugli beel, Kumargatha beel, Beria beel, Begi beel, Dala Bandha beel,Kanchka beel, Dubatra beel, Akta para beel, Lokma beel, Humai beel, Asharanir beel, Barohaor beel, Baichhajurir beel, Perua beel, Bilura beel and Kudailla beel. The Khals connecting the beels with the rivers are ;Thakurer Khal, Hautia Khal (Hautia Regulator), Khaim Konar Khal, Thakurbair Khal, Jatrabari Khal (Jatrabariregulator), Ahmmak Khalir Khal, Ghoradubar Khal (Ghoraduba Regulator), Naya Parar Khal,Naya Khal, Bikar Khal, Baishnab Khal, Bhatiparar Khal, Bharti Kholar Khal. The water of these beels are mostly used for irrigation and fish habitat.

1.2 Project Descriptions

Bangladesh Water Development Board (BWDB) implemented the Updakhali Haor project with GOB fund. The project was started in 1996-97 and completed in 2001-02 financial year. The major physical interventions of the project are submersible embankment, regulators and closures. The main objective of the project was to protect Boro crops from early flash flood as well as to protect life and properties from flooding

The water management infrastructures of the Updakhali Haor scheme include the following:

- 31 km submersible embankment
- 5 number of regulators
- 80 inlets and 5 outlets
- 1 closure

1.3 Present Status of the Project Interventions

The local people sometimes cut the embankment (Public cut) to transport the harvests from haor area to their home as there are very limited outlets. Besides, the farmers also cut the embankment to expedite the drainage after flood to start cultivation in dry areas. Moreover, the embankment also gets breached due to heavy onrush of flood water. If the breached points or public cuts are not repaired in due time i.e. before onset of flash flood water enters into the haor through these weak points and damages crops. Most of the regulators in the study area has been silted up, hence causing sedimentation and drainage problem.

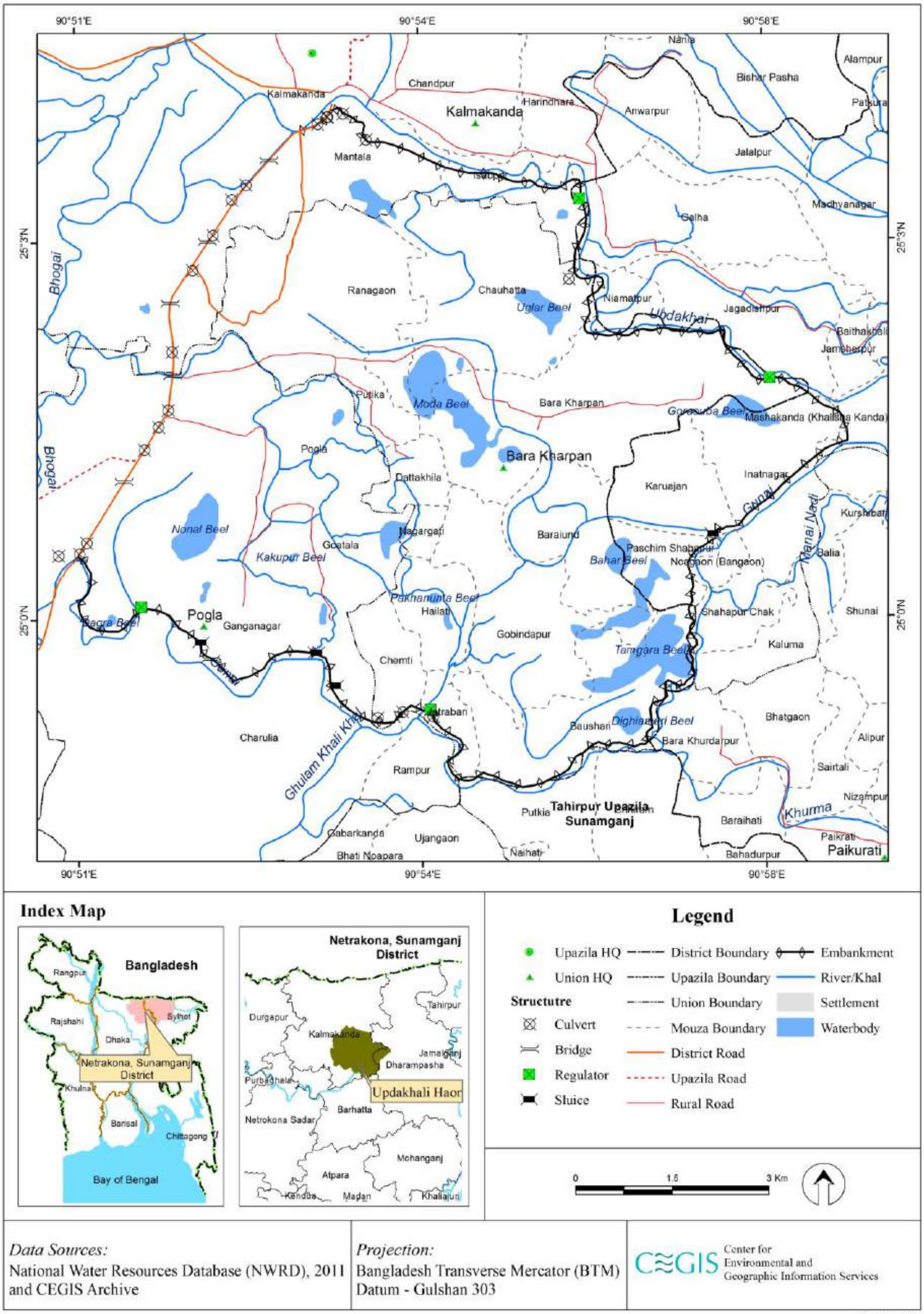

Figure 1.1: Hydrologic Features of Updakhali Haor

2. Water Resources

2.1 Flooding

Pre Project

In pre-project condition, flash floods due to heavy rainfall in the upstream region during pre-monsoon period flowed through the Updakhali and Gunai rivers and usually entered in the project area by April. In the full monsoon period, about 70-80% of project area got inundated and water stayed for about 2-3 months.

Post Project

The project interventions have delayed the entry of flood water by 10-20 days. Afterwards, the flood normally enters by May through the five regulators. Thereafter, monsoonal flood comes and overtops the submergible embankment which continues till the end of July. However, due to unprecedented rainfall in the upper catchment in Meghalaya, the flash flood sometimes comes early like it happened by April in the last three year (2015-17). On the other hand, If the breached points or public cuts are not repaired in due time i.e. before onset of flash flood, water enters into the project through these weak points and damages the standing crops. Recession of flood water starts from the end of August and by mid-September, most of the project area become dry except the lowlands.

Impact

Interventions of the project have delayed the entrance of flash flood by 15-20 days. However, in recent years (2015-17), flash flood entered into the project a bit early due to unprecedented rainfall both in the upstream region and also inside the country. The flash flood also enters, if the breached points and public cuts are not repaired in due time.

2.2 Drainage

Pre Project

North and west sides are relatively high and south-east part of this haor is relatively low-lying area. The higher land slope of this region helped drainage of flood water as there was no embankment and the entire area was open. As a result during pre-project period, it took 4-5 months to drain-out of flood water to the Updakhali and Gunai rivers.

Post Project

Interventions of the project have slowed down the drainage of water in post monsoon. Moreover, siltation in the khals and at the mouth of the outlet structures also impedes draining out the water quickly from project area during post monsoon period. The eastern portion becomes inundated quickly due to heavy rain and stays for a longer period, as there is no connection with Updakhali and Gunai River. But, drainage congestion doesn’t occur in the north-eastern portion of the project area. Local people informed that after construction of the interventions, drainage congestion occurs frequently for a short duration only in the low lying area in southern portion of the project.

Impact

The drainage has been slowed down as well as impeded in the eastern portion due to the interventions of the project.

2.3 Sedimentation

Pre Project

The silt and other coarse materials carried by the flash flood during pre-project period got deposited in the rivers as well as in the project area.

Post Project

After construction of submersible embankment and regulators, the silt and other coarse materials cannot enter into the project area during flash flood, which is mostly deposited in the rivers. However, sometimes, the silts and other coarse materials enter the project through the breached point and public cut, if not repaired in due time. The river bed levels are rising due to rapid siltation reducing the conveyance capacity of the rivers. Besides, runoff also erodes soil from agricultural land and embankment which get deposited in the beds of rivers, khals and beels. Moreover, soil from embankment breach and public cuts also gets deposited in the rivers, khals and beels.

Impact

Siltation in both peripheral rivers and internal rivers, beels and khals has increased compared to pre-project period. Presently, the land inside the project is being exposed in the dry season and farmers practice cultivation there since the last 10-12 years.

2.4 Navigation

Pre Project

During pre-project period, there was navigational connectivity between the haor and the peripheral rivers throughout the year.

Post Project

Navigational connectivity between the haor and the peripheral rivers mainly remains operative during monsoon. Besides, navigation also operates through the breached points and public cuts (if it happens) before repairing in January/February. Moreover, boats can ply within the haor for fishing and other purposes. However, navigational connectivity does not persist during pre-monsoon due to repairing of submersible embankment.

Impact

The navigational connectivity between the project area and the peripheral river has not been affected in monsoon but it does not operate during post-monsoon period. Moreover, navigation in the peripheral rivers has also not been affected appreciably.

3. Land Resources

The project area has fallen in two Agro-ecological zone, namely: Sylhet Basin (AEZ-21) and Northern and Eastern Piedmont Plains (AEZ-22). Non-calcareous grey floodplain soil (non-saline) and acid basin clays are the dominant soil. The top soil texture are clay and loam; where clay texture is dominant. The soils are slow permeable and have a medium moisture holding capacity. The land type characteristics are not uniform within the project area. About 64% of cultivable areas are low to very low land where minimum flooding depth is above 1.8 meter during the monsoon period. The recession of surface water from most of the agriculture land starts at early October and become free of flood water in end of December.

Two indicators (Land use and Sand carpeting area) have been selected for assessing the impact on land resources due to structural interventions in Haor ecosystem. The land use and sand carpeting information under pre-project and existing situations were identified through analysis of the available archived satellite images of CEGIS and it was verified through Focus Group Discussion (FGD) and Key Informant Interview (KII).

3.1 Land Use

Pre Project

The gross area of pre project has been considered as similar to post project. The gross area was 8,005 hectare under pre-project situation of which Net Cultivated Area (NCA) was 6,811 hectare. The rest area was covered with water bodies (Baor, Beels, river and Khals), forest (herb, shrub and tree) and settlements including homestead vegetation. Details are presented in Table 3.1.

Post Project

The gross area remaining same and the Net Cultivated Area (NCA) is 6,867 hectare. The rest area are covered with waterbodies (Baor, Beels, river and Khals), forest (herb, shrub and tree), and settlements including homestead vegetation. Details are presented in **Table 3.1**.

Impact

Forest and water bodies and forest area have decreased about 23 and 155 hectare respectively. On the other hand, net cultivated area and rural settlement area have increased about 56 and 114 hectare respectively. Detailed impacted area is presented in **Table 3.1**.

Table 3.1: Detailed Land use in Updakhali Haor System

Land use	Pre-project area (ha)	Post-project area (ha)	Impact (Post-project –Pre-project)
Net Cultivable Land (NCA)	6,811	6,867	56
Water bodies	514	359	-155
Forest	26	3	-23
Settlement	653	767	114
Others	0	8	8
Total	**8,005**	**8,005**	**0**

Sources: Analysis 30 m Resolution Landsat Satellite Images, March: 1989 and 2015

3.2 Land Degradation

Pre Project

There was no information about land degradational issue before interventions.

Post Project

Sand carpeting is the main issue of land degradation in this project area. Local farmers reported, they observes sand carpeting after 2008 at the location of Mashakandi (150 ha), Bausari (40 ha), Failathi and Paschim Shahapur (60 ha) mouza fallen in the southeast part of the scheme area. Total about 250 ha land was carpeted with sand, of which now only about 15 ha land comes under ground nut or other sandy soil preferable corps production, 35 ha use for fish production and rest 200 ha land non-productive.

Impact

Total about 250 ha land carpeted with sand at Mashakandi (150 ha), Bausari (40 ha), Failathi and Paschim Shahapur (60 ha) mouza. Due to sand carpeting (land degradation) farmers cannot cultivate any crops in 200 ha land and rest 50 ha area use for fish and crop (ground nut) production.

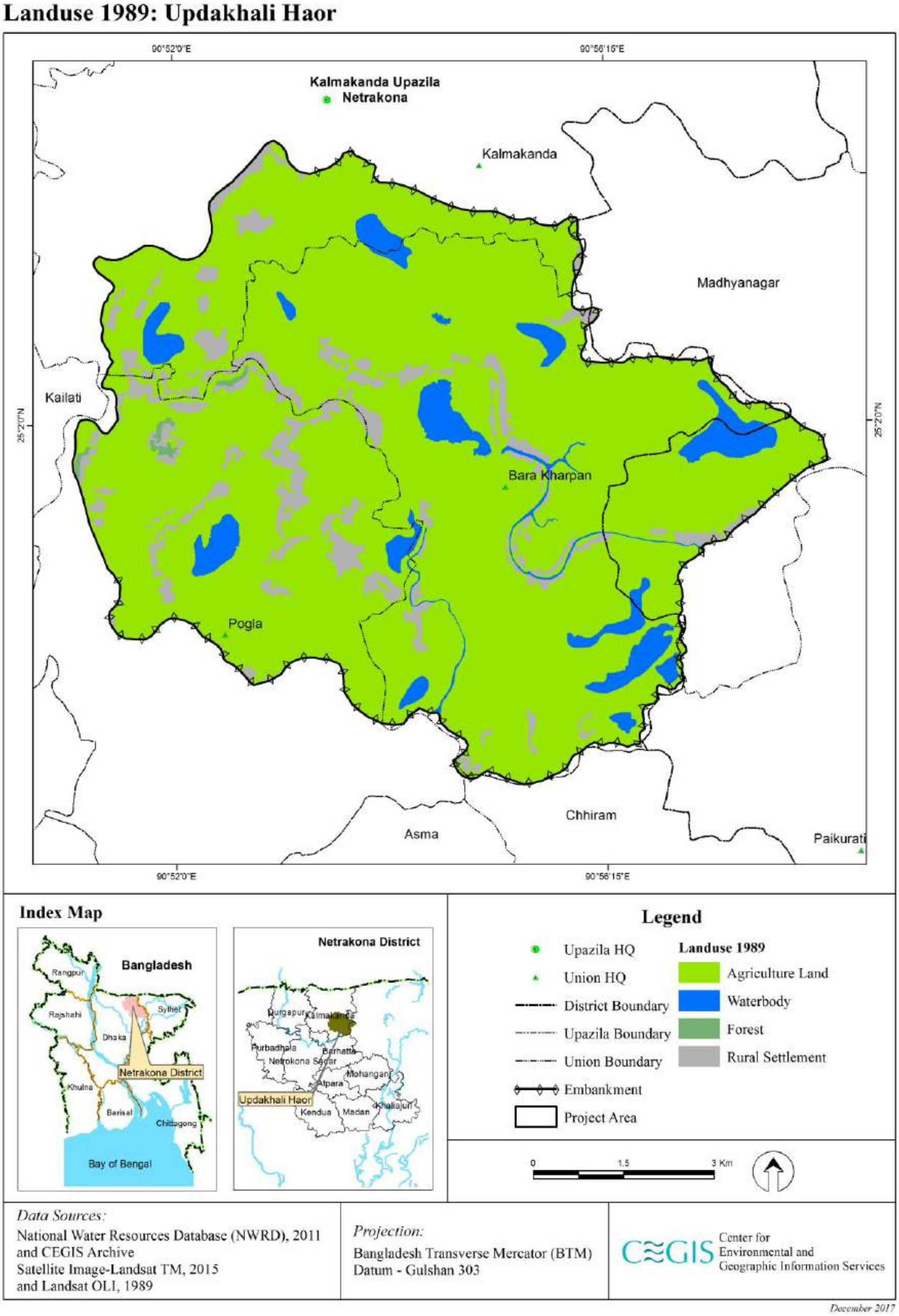

Figure 3.1: Land use of Updakhali Haor (1989)

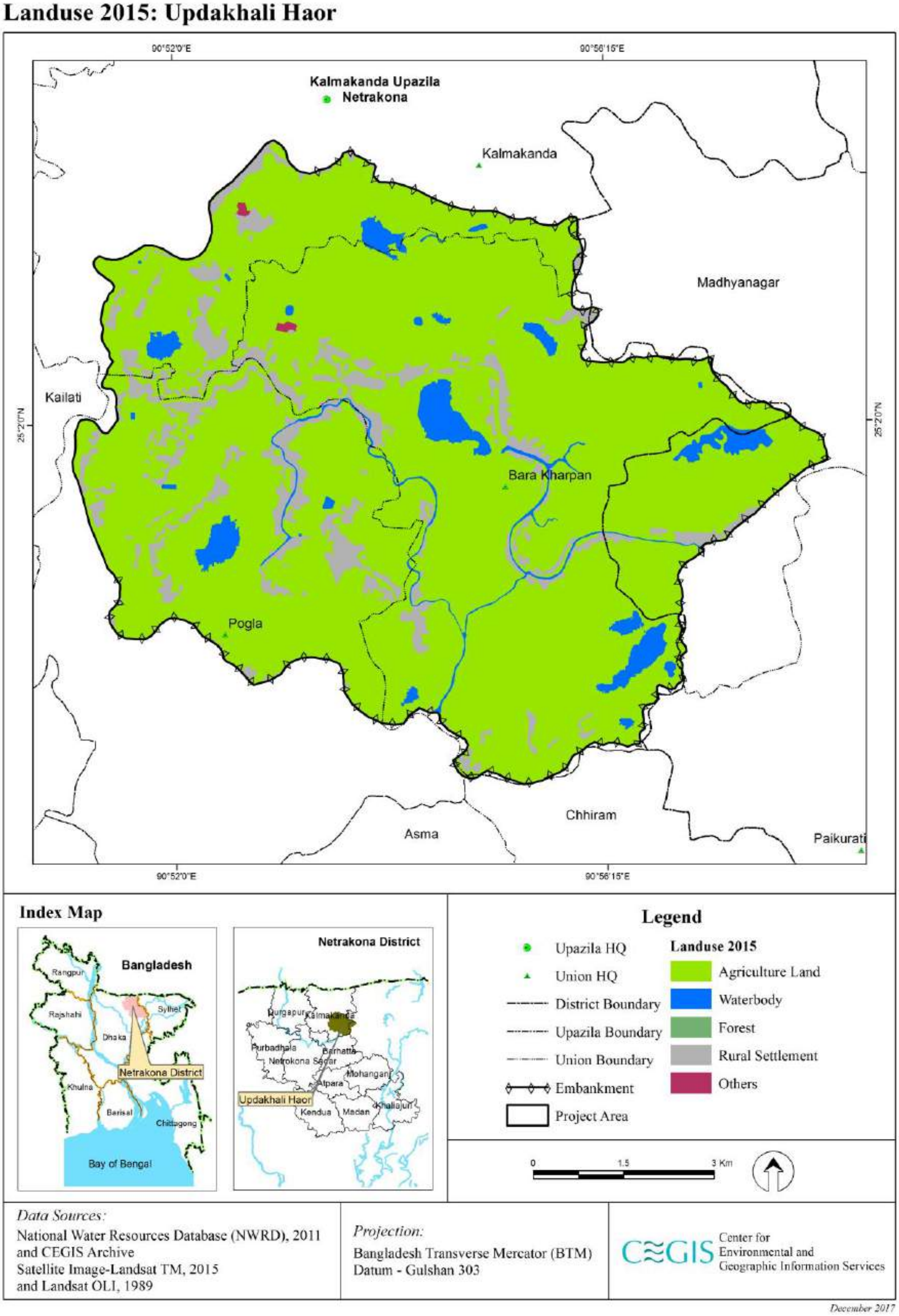

Figure 3.2: Land use of Updakhali Haor (2015)

4. Agriculture Resources

Boro rice is the main crop in Haor areas. In most cases, pre-matured or matured Boro crops are damaged by early flash flood which generally happened due to pre-monsoon heavy rainfall in the hilly areas. Besides, drainage congestion and irrigation water scarcity due to siltation of rivers, Khals and Beels are the another problem for Haor agriculture.

Six indicators (cropping intensity, crop area, crop production, crop damage, irrigation and use of agro-chemicals) have been selected for assessing the impact on agriculture resources due to structural interventions in Haor ecosystem. The information of these indicators were collected from both primary and secondary sources. The primary data were gathered from stakeholders through Focus Group Discussion (FGD) and Key Informant Interview (KII). The secondary data were collected from Bangladesh Bureau of Statistics (BBS) and field level Department of Agricultural Extension (DAE) office.

4.1 Cropped Area, Cropping Pattern and Intensity

Pre Project

Before the project interventions, the Net Cropped Area (NCA) was 6,811 hectare, where dominant cropping pattern was Fallow-Fallow-Local Boro. The land type of this scheme area was low land (about 58% of NCA) followed by medium high land, medium low land, very low land as presented in **Table 4.1**.

Farmers usually grew Lt. Aman, local Boro, HYV Boro and Robi crops in Kharif-II and Rabi season. Different varieties of Lt. Aman like Birui, Paizam, Parizat, Kalizira, Basfol, Poicham; local Boro like Gochi, Boro, Rata, Tepi Boro, Boiakawri, Anaimma,Antishail and HYV Boro like BR 11, BRRI Dhan 28were very much popular among the farmers. Cropping intensity of this area was 127%. Detailed cropping pattern by land type under Pre-project situation is presented in **Table 4.1**.

Table 4.1: Pre-project Cropping Pattern of Updakhali Haor System

Land type	Kharif-I (March-June)	Kharif-II (July-October)	Rabi (November-February)	Area (ha)	% of NCA
Medium High Land(F_1)	Fallow	Lt Aman	Robo crops	320	5
	Fallow	Lt Aman	HYV Boro	1,723	25
Medium Low Land(F_2)	Fallow	Lt. Aman	Fallow	405	6
Low Land(F_3)	Fallow	Fallow	Local Boro	3,950	58
Very Low Land (F_4)	Fallow	Fallow	Local Boro	200	3
	Fallow	Fallow	Fallow	213	3
Total				**6,811**	**100**
Cropping intensity (%)				**127**	

Sources: CEGIS estimation based on field information and image analysis, October; 2017

Post Project

The project area became protected from early flash flood due to the interventions, which influenced farmers to grow HYV Aman, Hybrid Boro and HYV Boro crops instead of Lt. Aman and local Boro. HYV Boro crops also produces higher yield than local varieties. The most popular varieties which are used in the project area are BRRI dhan 28, BRRI dhan 29, and BRRI dhan48. Farmers prefer, Lt. Aman: Birui, Rotishail, Chapali, Shoealpuri, Kalizira and HYV Aman: BRRI dhan 28, BRRI dhan 49, BRRI dhan 52 in Kharif-II season, Local Boro: Sholakia, Boro, Tapi Boro and HYV Boro: BRRI dhan 28, BRRI dhan 29 in Rabi season. Moreover, Hybrid Boro (Aftab02, Hira and Jholok) varieties are introduced in this area but not become as popular as HYV variety. The Net Cultivable Area (NCA) has been increased to 6,867 hectare after interventions. Dominant cropping pattern of the project area is Fallow - Fallow - HYV Boro covering 52% of the NCA. The cropping intensity of the area is 133%. Detailed cropping pattern by land type under with project situation is presented in **Table 4.2**.

Table 4.2: Post-project Cropping Pattern of the Updakhali Haor System

Land type	Kharif-I (March-June)	Kharif-II (July-October)	Rabi (November-February)	Area (ha)	% of NCA
Medium High Land(F_1)	Fallow	HYV Aman	Robo crops	380	6
	Fallow	HYV Aman	HYV Boro	1,680	24
Medium Low Land(F_2)	Fallow	Lt Aman	HYV Boro	410	6
Low Land(F_3)	Fallow	Fallow	HYV Boro	3,603	52
	Fallow	Fallow	Hybrid Boro	180	3
	Fallow	Fallow	Fallow	200	3
Very Low Land (F_4)	Fallow	Fallow	Local Boro	414	6
Total				**6,867**	**100**
Cropping intensity (%)				**133**	

Sources: CEGIS estimation based on field information and image analysis, October; 2017

Impact

The Net Cropped Area has been increased to 496 hectare after taking interventions. The cultivated area of Lt.Aman and local Boro has gradually been decreased and replaced by HYV Aman, Hybrid Boro/HYV Boro crops due to its higher yield rate and ensured early flash flood protection by project interventions. Impact on cropped area is presented in **Table 4.3**.

Table 4.3: Impact on Cropped Area in Updakhali Haor System

Crop name	Pre-project Area(ha)	Post-project Area(ha)	Impact (Post-project-Pre- project) Area(ha)
Lt. Aman	2,448	410	-2,038
HYV Aman		2,060	2,060
Hybrid Boro		180	180
HYV Boro	1,723	5,693	3,970
Local Boro	4,150	414	-3,736
Robi crops	320	380	60
Total	**8,641**	**9,137**	**496**

Source: CEGIS estimation based on field information, October; 2017

4.2 Crop production

Pre Project

The estimated total annual crop production of the project area was about 22,975 tons after loss of 5,106 tons before any interventions. Detailed crop production statistics before interventions is presented in **Table 4.4**.

Table 4.4: Annual Crop Production in Updakhali Haor System under Pre-project Situation

Crop name	Total crop area(ha)	Damage free area		Damaged area		Annual production (ton)	Production lost(ton)
		Area (ha)	Yield (ton/ha)	Area (ha)	Yield (ton/ha)		
Lt. Aman	2,448	1,714	2.3	734.40	1.1	4,749	881
Local Boro	4,150	2,698	2.8	1,452.50	1.3	9,441	2,179
HYV Boro	1,723	1,206	3.5	516.90	1.4	4,945	1,085
Robi crops	320	224	15.0	96.00	5.0	3,840	960
Total	**8,641**	**5,841**	**-**	**2,800**	**-**	**22,975**	**5,106**

Source: CEGIS estimation based on field information, October 2017

Post Project

After the implementation of the project, hydrological regime of the project area is changed. Farmers started to cultivate HYV Aman, Hybrid Boro and HYV Boro due to presence of submersible embankment, compartmental embankment, regulator and closure, which protect their crops from early flash flood. Hence, total annual crop production is about 36,600 tons with loss of 6,196 tons after interventions. Detailed estimation of crop production after interventions is presented in **Table 4.5**.

Table 4.5: Annual Crop Production in Updakhali Haor System under Post-project Situation

Crop name	Total crop area(ha)	Damage free area		Damaged area		Annual production (ton)	Production lost(ton)
		Area(ha)	Yield (ton/ha)	Area(ha)	Yield (ton/ha)		
Lt. Aman	410	328	2.5	82.00	1.3	927	98
HYV Aman	2,060	1,607	3.8	453.20	1.2	6,650	1,178
Hybrid Boro	180	135	5.8	45.00	1.6	855	189
HYV Boro	5,693	4,270	4.5	1,423.25	1.8	21,776	3,843
Local Boro	414	298	2.9	115.92	1.8	1,073	128
Robi crops	380	285	16.0	95	8.0	5,320	760
Total	**9,137**	**6,923**	**-**	**2,214**	**-**	**36,600**	**6,196**

Source: CEGIS estimation based on field information, October; 2017

Impact

Additional 13,625 tons crop is being produced in post project situation. The crop production is increased due to the protection of flash flood which encourages the farmers for practicing high yielding variety instead of local variety. Detailed estimation of impact on crop production is presented in **Table 4.6.**

Table 4.6: Impact on Crop Production in Updakhali Haor System

Crop name	Pre-project Production(ton)	Post-project Production(ton)	Impact (Post-project-Pre- project)
Lt. Aman	4,749	927	-3,823
HYV Aman		6,650	6,650
Hybrid Boro		855	855
HYV Boro	4,945	21,776	16,831
Local Boro	9,441	1,073	-8,368
Robi crops	3,840	5,320	1,480
Total	**22,975**	**36,600**	**13,625**

Source: CEGIS estimation based on field information, October; 2017

4.3 Crop Damage

Pre Project

Flash flood was the main cause of crop damage in pre-project situation. Before harvesting of Boro/Robi crops, water entered into the haor area and damaged the crops. So, farmer of this area suffered due to damaging of their crops in every year. Total crop damage in the project area was 5,106 tons annually. Detailed estimation of crop damage is presented in **Table 4.4.**

Post Project

Updakhali haor is now protected from early flash flood by the project interventions which basically performed well up to 2010. After that, most of the year, flood water enters into the haor before harvesting of Boro/Robi crop (early to mid-March) due to low height of submersible embankment and malfunctioning of structures.

Floodwater enters into the Updakhali haor through the surrounding Gumai and Updakhali River either by overtopping or by breaching the embankment at several locations. The height of embankment of the haor is low in comparison with the design level and more than 11 breaches are located in this embankment. Every year BWDB closes the major breaches and entrances of the khal. The main reason for flooding in this haor over the years is that the rivers have silted up and their water flowing capacities are gradually reducing. The excessive sedimentation makes rivers incapable of holding and conveying floodwater, which creates excessive pressure on earthen embankment. Moreover, plant height of hybrid/HYV is less than local varieties and growing period of most of the Hybrid/HYV varieties are higher than local varieties except BRRI dhan28. So, flood water affects the whole crop area at a time. The annual crop damaged area was total 24 % due to natural calamities (flash flood and over rainfall etc) and non-functional condition of submersible embankment and sluice gate as well as siltation of rivers, khals, and beels. The devastating floods of 2004 inundated the haor on the mid-week of April. Local people reported around 100% of Boro both HYV and local varieties were damaged by the devastated flood and late flood damaged the seedbed of T Aman and around 50% of the T Aman crop. B Aman crop were also fully damaged in this year due to sudden rise of the floodwater and wave action. In 2007, around 90% of Boro both HYV and local varieties were damaged by the devastated flood. But, this year (2017), around 100% of Boro crop areas are damaged at pre-mature stage. Most vulnerable mouzas such as Kashobpur, Ebrahimpur, Molgona, Ambaria, Gongga nagar and Borkapon are identified in this respect. Total crop damage is recorded as 6,196 tons after interventions. Detailed estimation of crop damage after interventions is presented in **Table 4.5**.

Impact

Though, the crop damage area has been decreased from 32% to 24% after interventions, especially after 2010. Therefore, crop damage has been increased to 6,196 tons. The crop damage area is increase day by day due to the malfunctioning of the interventions and reduced water carrying as well as retention capacity of surrounding rivers, khals and beels. Detailed impact assessment on crop damage is presented in **Table 4.7**.

Table 4.7: Impact on Crop Damage in Updakhali Haor System

Crop Name	Pre-project Production loss (ton)	Post-project Production loss (ton)	Impact (Post-project-Pre- project)
Lt. Aman	881	98	-783
HYV Aman		1,178	1,178
Hybrid Boro		189	189
HYV Boro	1,085	3,843	2,757
Local Boro	2,179	128	-2,051
Robi crops	960	760	-200
Total	**5,106**	**6,196**	**1,090**

Source: CEGIS estimation based on field information, October; 2017

4.4 Irrigation

Pre Project

Before initiation of the project, only surface water was used for irrigating Local Boro and Rabi crops. The local people normally transplanted this crop immediately after the floodwater recedes and the land is under shallow inundation. Local farmer reported that they stored water with help of bundh/dyke management and irrigated their crop with the help of flooded water in the low lying part of the Haor. They also used traditional modes like *Seuti, Don and Cone* for irrigating their crop from surrounding rivers, Beels and Khals during dry season. Prior to the implementation of the project, irrigation water was more available than the requirement of crops.

Post Project

After implementation of the project, the irrigation water demand has been increased due to cultivation of high water demanding Hybrid/HYV Boro instead of Local Boro crop. On the other hand, the availability of surface water is being reduced due to siltation of surrounding rivers, khals and beels of the project area. Therefore, the scarcity of irrigation water has been observed from early February to end of March in most of the year. Mainly Low Lift Pumps (LLPs) is being used for lifting surface water instead of traditional mode. In addition, about 25% of crop area is being irrigated from groundwater by using Deep Tubewell (DTW).

Impact

There was deficit of irrigation water due to increase of water demand and decrease of water availability during dry season. The irrigation water demand has increased for cultivating high yielding crop variety. On the other hand, surface water irrigation availability has decreased due to siltation of rivers, khals and beels of the project area.

4.5 Agro-chemicals use

Pre Project

Farmers of the project area cultivated Lt Aman, Local Boro and Rabi in pre-project situation. They apply small amount of agro-chemicals for crop cultivation. However, some farmers also used inorganic fertilizer like mixed grass and rice straw in the crop field for the restoration of soil fertility. At pre-project situation about 760 tons chemical fertilizers were used in this area for crop cultivation per year. Detailed use of agro-chemicals under pre-project situation is presented in **Table 4.8**.

Table 4.8: Use of Agro-chemicals in Updakhali Haor System under Pre-project Situation

Crop name	Fertilizer (Kg/ha)				Total (kg/ ha)
	Urea	TSP	MP	ZnSo4	
Lt. Aman	50	10			60
HYV Boro	90	20	20		130
Local Boro	60	10	10		80
Robi crops	100	40	40	-	180

Source: CEGIS estimation based on field information, October; 2017

Post Project

Generally more agro-chemicals are required for cultivating HYV Aman and Hybrid/HYV Boro crops. So, farmers applied more agro-chemicals for HYV Aman and Hybrid/HYV Boro crop cultivation. Total about 2,758 tons chemical fertilizers, 6.5 Kiloliter liquid and 15.6 tons granular/powder pesticides were used in the study area for crop cultivation per year. Detailed use of agro-chemicals under post-project situation is presented in **Table 4.9**.

Table 4.9: Use of Agro-chemicals in Updakhali Haor System under Post-project Situation

Crop name	Fertilizer (Kg/ha)				Total (kg/ ha)	Pesticides	
	Urea	TSP	MP	Others		Liq. (ml/ha)	Gran. (Kg/ha)
Lt. Aman	120	40	40	0	200	300	0.8
HYV Aman	140	50	50	0	240	400	1
Hybrid Boro	200	80	80	0	360	1000	2.2
HYV Boro	180	75	75	0	330	800	2
Local Boro	160	70	70	0	300	800	1.2
Robi crops	160	70	70	0	300	1200	2.5

Source: CEGIS estimation based on field information, October; 2017

Impact

Use of agro-chemical has increased largely under with project situation compared to pre-project situation. Additional 1,998 ton of chemical fertilizers, 6.5 kilolitre liquid and 15.6 ton granular pesticides are used for crop cultivation in this area. Detailed impact on use of agro-chemical is presented in **Table 4.10**.

Table 4.10: Impact on Agro-chemicals in Updakhali Haor System

Crop name	Pre-project			Post-project			Impact		
	Total Fertilizer (ton)	Pesticides		Total Fertilizer (ton)	Pesticides		Total Fertilizer (ton)	Pesticides	
		Liquid (Kiloliter)	Powder/ Granular (ton)		Liquid (Kiloliter)	Powder/ Granular (ton)		Liquid (Kiloliter)	Powder/ Granular (ton)
Lt. Aman	147	0	0	82	0.1	0.3	(65)	0.1	0.3
HYV Aman	0	0	0	494	0.8	2.1	494	0.8	2.1
Hybrid Boro	0	0	0	65	0.2	0.4	65	0.2	0.4
HYV Boro	224	0	0	1,879	4.6	11.4	1,655	4.6	11.4
Local Boro	332	0	0	124	0.3	0.5	(208)	0.3	0.5
Robi crops	58	0	0	114	0.5	1.0	56	0.5	1.0
Total	**760**	**-**	**-**	**2,758**	**6.5**	**15.6**	**1,998**	**6.5**	**15.6**

Source: CEGIS estimation based on field information, October; 2017

5. Livestock Resources

Livestock and poultry, being an essential element of integrated farming system, play an important role in the economy of the Haor area. Livestock provides significant draft power for cultivation, threshing and crushing of oil seeds; cow dung as a source of manure and fuel; a ready source of funds; and meat, milk and eggs for human consumption. A large number of livestock are reared in Haor areas but constrained by flash flood causing inundation of large areas during most of the time in the year. This area is famous for duck rearing due to availability of natural feed for ducks in natural large water bodies. All of livestock species suffer much due to shortage of feed, outbreak of waterborne diseases and inadequate shelter facilities. The livestock rearer in the Haor areas do not get fair price due to poor communication as well as lack of marketing facilities.

The indicator status of livestock has been selected for assessing the impact of the project. The status of livestock population data were collected from Livestock Census (1986), Agriculture census (1996 and 2008) of BBS. The status of livestock feed and fodder, diseases, marketing facilities information were gathered from stakeholders through Focus Group Discussion (FGD) and Key Informant Interview (KII).

5.1 Status of Livestock Population, Feed and Diseases

Pre Project

According to livestock census 1996, the livestock and poultry population in the project area were 8,780 cattle, 4,470 goats, 27,580 chicken and 3,440 ducks (**Table 5.1**). Before implementation of the project, the major feed available to ruminants was mostly crop residues (rice straw) supplemented with weeds from cultivated fields. They are to depend on naturally grown grasses in Kandas and alongside roads and embankments. Most of the year before implementation of the project, the crops were to damage by early flash flood. As a result, shortage of feed from crop residues, reduction of grazing facilities seriously affect livestock rearing. That time, the small holders were to depend on water hyacinth and other aquatic plant for their cattle. The major poultry feeds were rice bran, broken rice, kitchen wastes like rice, rice-gruel, vegetables, fish wastes etc. In addition, the duck usually scavenge in the nearby waterbodies like haor, beel, khal, river or any other low lying areas; mainly eat various types of aquatic insects, small fish, shell or snails. Major livestock and poultry diseases were Gola Fula (Haemorragic Septicemia), Foot and Mouth Diseases (FMD), Pox and Cholera, Duck Cholera, Fowl Pox and Fowl Cholera etc. The most vulnerable period was between July to November for spreading diseases to livestock and poultry populations. Mortality rate of the livestock/poultry was higher due to poor shelter condition and they lived in unhygienic condition. Marketing facilities was not in good condition and price was also low due to less demand of their products and by products. Producer consumed their products at family level and additional products were sold at local village market.

Livestock provide significant draft power for cultivation and threshing, cow dung as a source of manure and fuel; a ready source of funds and meat, milk and eggs for human consumption. Most of the households were raised poultry and livestock, which significantly reduce poverty through generating income. Details of livestock of this scheme area are presented in **Table 5.1**.

Table 5.1: Status of Livestock/Poultry in Updakhali Haor System

Livestock/ Poultry Category	Pre-project		Post-project		Impact
	No of Households having Livestock	Total No of Livestock	No of Households having Livestock	Total No of Livestock	Number of Livestock Population
Cattle	3,080	8,780	4,690	12,290	3,510
Goat	1,530	4,470	1,950	4,580	110
Chicken	4,950	27,580	5,880	36,800	9,220
Duck	3,180	18,000	3,440	19,370	1,370

Source: CEGIS estimation based on agriculture census (1996 and 2008)

Post Project

According to agriculture census 2008, the livestock and poultry population in the project area are 12,290 cattle, 4,580 goats, 36,800 chicken and 19,370 ducks (**Table 5.1**). After implementation of the project, crop is protected from early flash flood. As a result, the feed availability of livestock is increased due to increase of crop production. However, some of the year, the crops were damaged by early flash flood. In that year, the small holders were depend on water hyacinth and other aquatic plant for their cattle. The poultry feeds are same as in pre project situation. On the other hand, more or less similar diseases are found in post project situation. The mortality rate of the livestock/poultry became negligible during the project period, due to extension works at farmers' level such as immunization and insemination program by Department of Livestock (DLS). Marketing facilities during dry season also improved due to improvement of the communication system by constructing the submersible embankments. Therefore, market prices are increased due to high demand of products and by products.

Impact

From 1996 to 2008, about 3,510 cattle, 110 goat, 9,220 chicken and 1,370 duck have increased due to the reduction of flood vulnerability, improvement of marketing facilities and strengthening of livestock extension services. Details about impact on livestock are presented in **Table 5.1**.

6. Fisheries Resources

Updakhali Haor system is bounded mainly by the Gunai River which acts as the major water sources for maintaining sustainability of fish habitat. Beside this, the Updakhali River, the Holi River and the Bubai River also surround the Haor and contribute a lot. The Haor is fed by a number of connecting Khals of which important ones are Thakur Khal, Jatrabari Khal, Gouradobar Khal, Khaim Konar Khal, Bartikholar Khal, etc. The Haor possesses a large number of Beels (sizes varies from 10 to 60 ha) of which major ones are Mahishaura Beel, Urdha Beel, Nanai Beel, Meda Beel, Gouradoba Beel, Bahar Beel, Tamgara Beel, Pakhanunta Beel, Dighiamuri Beel, etc. According to local people, Mahishaura Beel, Urdha Beel, Nanai Beel, Meda Beel, Gouradoba Beel are the main fish breeding grounds of this Haor System. The field investigation revealed that the water centric interventions significantly control the hydrodynamic condition for fisheries resources of this Haor System.

6.1 Habitat Area

Pre Project

Fish habitat has been assessed from the landuse data that is extracted from the satellite image of 1989. The estimated total area of fish habitat of the Haor was about 5,578 ha where capture fishery was the sole contributor. There were few ponds having no dike/low dike inundated naturally in monsoon flood. These ponds are considered under floodplain habitat. Floodplain shares the major part (about 91%) in the total habitat area followed by Beels and Khals. The breakdown of functionally different fish habitats of this Haor is given in **Table 6.1**.

Post Project

Similarly, the estimated fish habitat area has been assessed from the land use data, which extracted from satellite image of 2015, is about 5,578 ha. The total increment of fish habitat area by about 73 ha, which is contributed by the expansion of floodplain area of about 42 ha, Khal area of about 25 ha, newly created Baor area of about 1 ha and fish pond area of 2 ha. On the other hand, the decrement of fish habitat area by about 186 ha, which is contributed by the loss of Beel area. The habitat area loss overtops the habitat area gain and thus the resultant net loss of habitat area is about 113 ha. The increment of floodplain occurs may be due to siltation of river bed and associated decrease of river conveyance, Beel bed aggravation by loose top soil from agriculture field with run-off water and embankment breached soil, etc. The Baor is created to make an alternative way of river to protect the crops from flash flood. The breakdown of functionally different fish habitats of this Haor and habitat changes is given in **Table 6.1**.

Table 6.1: Breakdown of Fish Habitat Area by Habitat Type

Sl. No.	Habitat Category	Habitat Type	Area (Ha)		Impact (Ha) (Habitat Area Change)
			Pre -project, 1989	Post-project, 2015	
1	Capture Fishery	Channel/Khal	37	62	+25
2		Perennial Beel	477	291	-186
3		Floodplain	5,177	5,219	+42
		Sub-Total =	***5,691***	***5,572***	***-119***
5	Culture Fishery	Fish Pond	-	5	+5
6		Baor	-	1	+1
		Sub-Total =	***-***	***6***	***+6***
		Grand Total=	**5,691**	**5,578**	**-113**

Source: Fish habitat assessment based on field findings and image based landuse data, 1989 & 2015.

Impact

The net loss of fish habitat area in the Post-Project condition is about 113 ha, which is very negligible (about 2 %) in compared to pre-Project condition.

6.2 Habitat Condition

Pre Project

Floodplain was unregulated; timely entry of water into the Haor; silt carried by the rivers was dispersed over the Haor uniformly; river conveyance capacity was more. Local people opined that the Beels retained water in the dry season at a depth suitable for fishery. Among the Beels, Mahishaura Beel, Urdha Beel, Meda Beel had average depths ranges from about 2.5-3.0 m during dry season. Some of the Beels, such as Bahar Beel, Tamgara Beel, Pakhanunta Beel were shallow and dried up by bailing out of water in the month of December-January for harvesting fish. There were some Beels with leasing system and the lessee control the Khal mouth to hold water for fish production during recession period and to inhibit water entry into the Haor to protect Boro paddy during the onset of monsoon.

Little better ecosystem was maintained with the exchange of pre-monsoon nutrients between river and Haor; new water breeding stimulation to the small indigenous species (SIS) of fish; higher breeding success; less natural and fishing mortality; rich biodiversity; more sustainable fish production, etc.

Post Project

Floodplain is regulated; floodwater enters into the Haor in the late pre-monsoon; silt deposited on the river bed as dispersion of silt is hindered or restricted by the submergible embankment; decreased river conveyance capacity. Local people opined that some of the Beels retained water in the dry season at a depth less suitable for fishery. Among the Beels, Mahishaura Beel, Urdha Beel, Meda Beel average depths ranges from about 1.5-2.0 m during dry season. This is happened may be due to wash out of loose soil of agriculture land and breached embankment along with river borne sediment. Some of the Beels, such as Nanai Beel, Gouradoba Beel, Bahar Beel, Tamgara Beel, Pakhanunta Beel are shallow and dry up by bailing out of water in the month of December-January for harvesting fish.

There are some Beels with leasing system and the lessee control the Khal mouth (in some cases earthen closure made by BWDB, where water regulatory structures are not functioning) to hold water for fish production during recession period and to inhibit water entry into the Haor to protect Boro paddy during the onset of monsoon.

Ecosystem is being degraded gradually but lightly as some of the water control structures are not functioning properly. Exchange of pre-monsoon nutrients between river and Haor is being hindered or restricted to some extent by the submergible embankment; delayed new water entrance into the Haor and hampering breeding stimulation to the small indigenous species (SIS) of fish; in some cases egg deposited in the fish body; lower breeding success; little higher natural and fishing mortality; slightly declining trend in fish biodiversity; less sustainable fish production, etc.

Impact

The net physical condition of habitat is negligibly degraded and corresponding provisioning and supporting services of the ecosystem including fish and nursery ground respectively. However, the changes in habitat suitability condition of rivers, Khals and Beels in terms of quality occurred more due to man-made unconventional Beel fishery, illegal fishing (use of low mesh Kona Jal, over-fishing and indiscriminate fishing by large number of seasonal local fishermen, through Katha or Hichha- complete dewatering of leased water bodies for fishing), extensive use of agrochemicals and pesticides in paddy field, etc. rather than water centric interventions.

6.3 Fish Diversity

Pre Project

This Haor was rich in fish biodiversity containing over 100 species (**Table A-I of Appendix A**) in the pre-Project condition as some of the Beels are perennial and retained water at higher depths mentioned above suitable for fishery. The fish diversity particularly SIS was also facilitated by the unregulated lateral migration from river to Beel and Beel to river during pre-monsoon breeding season. Thus Beel resident fishes, particularly 'SIS' were dominant in the Beels and floodplain. Moreover, the abundance of large-sized adult fish species (Chital-*Notopterus chitala,* Pabda- *Ompok pabda* Rui- *Labeo rohita*, Catla- *Catla catla*, ,Ghonia- *L. gonius*, Boal- *Wallago attu,* Shol- *Channa striatus,* Gojar- *C. marulius,* Baghair- *Bagarius bagarius,* Guizza Ayre- *Sperata seenghala,* Boro Baim- *Macrognathus aculeatus,* Shar Punti-*Puntius sarana,* Foli- *N. notopterus etc.)* were also more. Furthermore, species were evenly distributed in the whole Haor system.

Post Project

Fish species diversity has the declining trend but in slow pace in the Post Intervention condition. This is happening may be due to many factors other than water control structures. The factors include habitat loss (both depth and area), water pollution, water regulatory structures, unplanned fisheries management, over exploitation of fish due to increase of fishers and modernization of fishing technology, indiscriminate fishing e.g. use of harmful fishing appliances, catching of hatchlings and brood fish, complete dewatering of leased water bodies (less than about 2ha) for fishing, etc. In consequence of the above phenomena, following fish species become locally unavailable or have become rare for last decade includes Pabda, Ayre Boro Baim, Shar Puti, Chital, Foli, Boro Chingri (*Macrobrachium rosenbergii*), Nanid (*Labeo nandina*), Mohashol- *Tor tor,* Riverine Pangas (*Pangasius pangasius*), Rui, Rani- *Botiya Dario,* Elang- *Rasbora elanga,* etc.

Impact

Comparing pre and post project conditions, it can be concluded that changes in fish species diversity and composition are not comprehensible in response to Project Intervention. Whatever changes in species diversity and composition between two phases are observed may be posed due to other anthropogenic factors mentioned above.

6.4 Fish Migration

Pre Project

Previously, the Haor was hydrologically linked with the Pasna Haor and Tanguar Haor through the Gunai-the Baulai River. For this reason, the abundance of large fishes like Rui, Catla, Ayre, Chital, Boal etc. were more. Local fishers stated that the lateral fish migration was open through the natural connectivity during pre-monsoon (March-May). Furthermore, most of the fries of riverine fishes may enter the Beels and floodplain along with flood water. However, successful lateral migration of different fishes e.g. riverine carps, large and small catfishes, etc. at their certain stages of lifecycle for food and residence is happening due to sufficient depths of the Beels.

Post Project

Pre-monsoon (15 April – 15 May) spawning/breeding migration of riverine (mainly the Gunai River) and Beel residence SIS fishes are mostly impeded through different connecting Khals due to submersible embankment along the Gunai River and water regulatory structures. Besides, riverine fishes migrate laterally to the Beels by overtopping or breaching of the existing embankment of the Haor during flooding months of Jaisthya-Ashar (15 May–30 June).

Impact

Comparing pre-project and post-project conditions, it can be concluded that migration of SIS is impeded during the pre-monsoon in the post-project condition and comprehensible impact has not been observed on fish migration in response to submersible embankment.

6.5 Fish Production Assessment

Pre Project

The estimated total fish production was about 3,677 metric ton (MT) in 1989 where floodplain shared the most about 93% followed by Beel and channel/Khal (**Table 6.2**).

Post Project

The estimated total fish production is about 3,891 metric ton (MT) in 2015 where floodplain shared the most about 94% followed by Beel, channel/Khal and fish pond as presented in **Table 6.2**. In the production assessment, the productivity of the corresponding year has been used.

Impact

Net increase in fish production in Post-Project condition is about 214 metric ton. As a whole, fish production has been increased by about 6%, whereas the floodplain production by about 6%, Khal by about 71% (**Table 6.2**). Only Beel production has been declined by about 15%.

This little increment in net productivity may not have direct impact of Post-Project, it may be influenced by Beel nursery programme, fishing pressure, etc. Moreover, the newly created habitat like fish pond have added additional 11 metric ton of fish. The breakdown of fish productions is presented in the following **Table 6.2** by functional unit of fish habitats.

Table 6.2: Breakdown of Fish Production by Functional Habitat

Sl. No.	Habitat Category	Habitat Type	Production (MT)		Impact (MT) (Production Change)
			Pre -project, 1989	Post-project, 2015	
1	Capture Fishery	Channel/Khal	7	12	+5
2		Perennial Beel	253	215	-38
3		Floodplain	3,417	3,653	+236
		Sub-Total =	***3,677***	***3,880***	***+203***
5	Culture Fishery	Fish Pond	-	11	+11
6		Baor	-	-	-
		Sub-Total =	***-***	***11***	***+11***
		Grand Total=	**3,677**	**3,891**	**+214**

Source: Source: Fish production assessment based on field findings and FRSS data, 1989 & 2015.

6.6 Fishing Appliances

Pre Project

Different types of fishing appliances are used to catch fishes. The mostly used fishing appliances are: gill net, Ghurni jal/Ber jal, push net, Khoira jal, hook, vair (one type of trap used to catch Guraicha), Gui (one type of trap used to catch small fishes), Chipp etc. Furthermore, illegal fishing practice was reported in the leased Beel. Dried up the whole Beel for harvesting benthic fish species may be considered as a good example of illegal fishing. However, this type of fishing depends on the leasing rotation system.

Post Project

Leaseholders (LHs) generally use Katha or Hichha as fish aggregating device (FAD) for fish. LHs usually harvest fish annually (generally in Kartik-Agrahayan). However, another type of fishing pressure has been increased day by day around the water control structures. The local fishers (particularly part-time fishers) create barrier at the mouth of water control structures by net for catching fish. Using Kona/Moshari Jal with small mesh gaining popularity among the fishermen but this kind of net inhibits the natural recruitment of stock in water body causes low productivity. This fishing pressure becomes more prominent during recession of floodplain water in the post-monsoon season.

Impact

The scheme is almost fully functional and possesses water control structures. For this reason, some deviation in fishing activities is found in response to Project intervention. Fishing is done at each of the water control structures which were absent in the pre project condition. On the other hand, fishing pressure is also increased with the increasing of fish demand and fish supply chain for both the national and global fish market.

6.7 Fishers Livelihood

Pre Project

Field findings reveal that about 10-20% of the Haor population was engaged in fishing and activities involved in fish supply chain for carrying out their livelihoods. Out of which a small percentages were commercial fishers (All of them from lower caste Hindu) and the rest of them were subsistence level fishers. Commercial fishers spent annually about 150-200 days (6-7 hrs/day) in fishing.

Post Project

At present more than 60% of Haor population are engaged in fishing activities. The number of fishers are increasing day by day due to demand of Haor fishes as well as increasing of market price. Commercial and subsistence level fishers spend annually more than 200 days (8-10 hrs/day) and 150-180 days (5-8 hrs/day) respectively in fishing. Though the fishers by inherit are decreasing day by day and a new group of part-time commercial fishers have been evolved and increased day by day for fishing at the mouth of the connecting Khals where there are water control structures. They mainly catch fish in the open water area in and around the Haor for carrying out their livelihoods. Competition in fishing is growing day by day in Haor area and many fishers by inherit migrate another for better livelihood.

Impact

It can be concluded that the number of part-time and subsistence fishers are increased in response to the Project Interventions.

6.8 Fisheries Management

Pre Project

Beel fisheries with leasing system were the prominent fisheries management as reported from the local people. All Beels were harvested in the months of February and March. Beel fishery was more sustainable. However, there was no community based fisheries management in this Haor.

Post Project

Beel fisheries with leasing system are also the prominent fisheries management in the post project condition. All leased Beels are harvested annually in end of Kartik-Agrahayan. The whole Beel is used to dry up for catching benthic fish species. However, this type of fishing depends on the leasing rotation system of the Government. Beel fishery is becoming less sustainable. There is a number of fisheries associations is a community based fisheries management in this Haor and no enforcement for limiting or controlling indiscriminate fishing at the water control structures.

Impact

Rotation length of time for fishing in most of the leased Beels is three-year rotation in the Post-Project condition. Though the Mahishaura Beel, in this case is exceptional. The Leaseholders have been holding water in the Beel for six years at a stretch and in monsoonal flood when the floodplains are flooded, they collect special toll from fishers to give them chance of fishing around the Beel. Leaseholders usually harvest fish annually (generally in Kartik-Agrahayan) with Katha or Hiccha (Fish Aggregating Device). Such over exploitation in conjunction with indiscriminate fishing at the water control structures is being happened mostly due to earn more money and driving fishery ecosystem into fragile resources.

7. Ecosystem

Updakhali haor has different landforms like settlements, cropfields, canals, beels and depressions which provide different ecosystems. Each of the ecosystems possesses unique composition of flora and faunal species. Ecosystems as well as association of flora and fauna have been changed over the time due to different anthropogenic pressures, human interventions and natural changes which are describing below.

7.1 Terrestrial Flora

Pre Project

Settlement platforms, cropfields and fallow passages are the major habitats for terrestrial flora of this haor. Settlement area was dominated with naturally grown species and with a little proportion of human influenced vegetation. Among the naturally grown vegetation, Pitali *(Trewia nudiflora),* Koroach *(Pongamia pinnata),* Kodom *(Anthocephalus cinensis)* and Baroon *(Crataeva nurvala)* was mostly common. Jarul *(Lagerstroemia speciosa)* was a naturally grown tree that was widely used for boat making. Settlement ridges were dominated with the amphibian plant Dhol Kolmi *(Ipomoea fistulosa)*. This plant also frequently grown all the fallow areas and utilized as fuelwood and support the settlements against wave actions during monsoon. Numerous wild herbs and shrubs were grown in croplands while it was in fallow condition.

Post Project

Settlement vegetation has been slightly changed during last few decades due to plantation of economic plants on homestead platforms. Usually, local people are tend to plant fruit and timber yielding plants for their feeding, fuel and thatching requirements. Population and coverage of Dhol Kolmi *(Ipomoea fistulosa)* are unchanged or even increase due to its high demand for cooking fuel and household fencing. Wild herbs and shrubs have decreased from the cropland as the farmers now cultivate more area and unwilling to left behind any fallow passage. Jarul tree have been reached occasional status as destruction of natural grooves for agriculture practices. Pitali, Baroon, Koroach are quite common all over the area.

Impact

Changes of terrestrial floral diversity and coverage have been occurred in settlement and cropfield vegetation due to change of people plantation choice and expansion of agricultural practice. Intervention is not responsible in this regards. The specific impacts on indicator flora has been represented below in **Table 7.1**.

Figure 7.1: Natural Vegetation at Settlement Edge and on Homestead Platform of the Haor Area

Table 7.1: Changes of Status of Indicator Species

Indicator Species	Pre Project	Post Project	Cause of status change	Type of Intervention that caused the change (If Yes)
Pitali	Very Common	Common in homesteads and Very common in all other area	Change of peoples plantation choice	-
Hizol	Occasional	Occasional	-	-
Koroch	Common	Common	-	-
Barun	Common	Common	-	-
Jarul	Common	Occasional	Agricultural expansion	-
Dhol Kolmi	Very Common	Very Common	-	-
Nol Khagra	Common	Occasional	Agricultural expansion	-

7.2 Terrestrial Fauna

Pre Project

Population and diversity of terrestrial fauna was moderate throughout the area. Natural vegetation of settlement area and fallow lands were provide the habitats for most of the terrestrial biota. In addition, the wildlife those found occasionally, were taken shelter inside the vegetation at river/khal bank, fallow land and *kanda*s. Jackals, mongoose, wild cats, mice etc. were among this group. Prey birds like Brahminy Kite and Black Kite were roaming large beel areas and nested on the trees at homesteads or *kandas*. Grassy and herb dominated areas inside cropfield were favor many reptiles like garden lizard, skinks, snakes etc. Pallas's Fish Eagle roam within the area during post monsoon and their occurrence was common beside the floodplains and other perennial waterbodies.

Post Project

Terrestrial faunal diversity has unchanged but population and occurrences have changed specially for the mammals like wild cat, mongoose and mouse. Hunting is the main cause in this regards, but habitat destruction for agricultural extension is also responsible for this change. Occurrence of Brahminy Kite, Black Kite, Pallas's Fish Eagle have reduced from all over the area for increasing the disturbance to their feeding habitat by the fishermen. Overfishing activities disfavor their preying and caused change of occurrences. Population of Snakes, skinks, lizards have still healthy within fallow lands, river bank vegetation and even within the homestead vegetation.

Impact

Terrestrial faunal diversity has unchanged but population and occurrences have changed over the time due to hunting and habitat disturbance. A specific status of the indicative terrestrial fauna is presented in **Table 7.2**.

Table 7.2: Impact on Terrestrial Fauna of the Haor Area

Indicator Species	Pre Project	Post Project	Cause of status change	Type of Intervention that caused the change (If Yes)
Pallas's Fish Eagle	Occasional	Rare	Habitat disturbance	-
Brahminy Kite	Very Common	Occasional	Habitat disturbance	-
Vulture	Rare	Not found	Habitat destruction and effect from cattle medicine	-
Fishing Cat	Occasional	Rare	Hunting and habitat destruction	-
Bengal Fox	Very Common	Common	Hunting and habitat destruction	-
Rat Snake	Common	Common	-	-

7.3 Aquatic Flora

Pre Project

Most of the aquatic flora were abundantly grown in seasonal floodplains and perennial waterbodies. Succession of Water lily/Sada sapla *(Nymphaea nouchali)* was remarkable in Perennial and deeply flooded seasonal wetlands. Keshordam *(Ludwigia abscendens)*, Helencha *(Enhydra fluctuans)* and *Hygroryza aristata* were frequently followed all the ditches, beels and even in homestead ponds. The indicator species Makhna *(Euryale ferox)* and Singara *(Trapa bispinosa)* was seasonally grown in large beels like 'Uglar Beel'. Free floating plants were also common throughout the haor area and Water Hyacinth/Kochuripana *(Eichhornia crassipes)* was the single most dominant species followed by *Salvinia, Azolla* and *Lemna*. Sedges and meadows were quite common. The entire aquatic flora were grown abundantly which favor many fishes, mollusks and amphibians.

Post Project

Siltation of waterbodies inside this haor has disfavor the luxurious succession of water lily. However, this situation is common at the peripheral area of Updakhali and Gumai River. Except the mentioned area, this free floating plant is quite common all the areas. Overfishing activities caused drastic depletion of Makhna *(Euryale ferox)* and Singara *(Trapa bispinosa)* populations. Although the abundance of the amphibian plant have increased (mentioned earlier) but the diversity and occurrences of free floating plants (i.e. Water Hyacinth, *Pistia* and *Azolla*) have changed and their occurrences are limited within untouched stagnant ditches and homestead ponds.

(Picture taken October 2017, from Ambari Bazar of Pogla UP)

Figure 7.2: Silt water of Gumai River disfavor succession of most aquatic flora at surrounding areas

Impact

Habitat condition of aquatic flora has been deteriorate in large river peripheral areas due to siltation and overfishing activities. This also caused population deterioration of indicator species. Interventions are not responsible for this change. A detail specific status of the aquatic flora is presented in **Table 7.3**.

Table 7.3: Status of Aquatic Flora of the Study Area

Indicator Species	Pre Project	Pre Project	Cause of status change	Type of Intervention that caused the change (If Yes)
Kochuripana	Common	Occasional	Destruction due to fishing activities	-
Shapla	Very Common	Reduced along the river peripheral area	Habitat destruction due to Siltation	-
Makhna	Common	Disappeared	Habitat destruction due to Siltation and fishing	-
Singara	Common	Rare	Destruction due to fishing activities	-

7.4 Aquatic Fauna

Pre Project

Existence of beels, ditches and seasonal floodplains provide habitats for numerous aquatic fauna. This haor was consisted rich population and diversity of aquatic faunal species as per informed by the local people. Fishes were occupied the top diversity and population which have been described in fisheries section of this report. Habitat condition of most perennial and seasonal wetland was favorable to the aquatic communities for having required depth and presence of diverse vegetation. Goradoba Beel, Uglar Beel, Mohishaura Beel, Dwalabandha Beel are the referable perineal wetlands those provided well habitats for numerous water dependent birds. Among this fauna, Great Egret, Cattle Egret, Little Cormorant, Little Egret, and Pond Heron were roaming all over the year or part of the year. Migratory birds were also visited each year at these beels. Cropfields, ditches and beel areas support rich population of amphibian and reptiles. There was evidence of Eurasian Otter (Lutra lutra) in large beel areas reported by local people. Among the mollusks, freshwater snail was commonly abode all types of waterbodies.

Post Project

Status has been changed in the case of some aquatic fauna due to habitat destruction for different anthropogenic pressures. Snail population has fall for over utilization as duck feeds. Landuse change squeezed the habitats of snakes, reptiles and water birds. Application of insecticides caused population depletion of Bull frog. Change of aquatic vegetation and overfishing by fine mesh nets deteriorated the habitat suitability for most of the aquatic fauna.

Impact

Changes have been occurred for habitat destruction and anthropogenic pressures, but no influence of intervention is mentioned. A detail impact of the interventions has been provided below in **Table 7.4**.

Table 7.4: Aquatic Fauna Status of the Haor

Indicator Species	Pre Project	Post Project	Cause of status change	Type of Intervention that caused the change (If Yes)
Indian Bullfrog	Very Common	Common	Landuse change	-
Migratory Birds/Waterbirds	Common	Occasional	Habitat destruction	-
Eurasian Otter	Occasional	Disappeared	Habitat destruction	-
Freshwater snails	Very Common	Decreasing all over the haor	Commercial Duck raring and fishing with fine mesh nets	-

7.5 Swamp Forest and Reeds

Pre Project

The haor was possessed about 21 ha of swamp forest at the elevated ‘kandas’. Hizol *(Barringtonia acutangula)* and Koroach *(Pongamia pinnata)* were the dominant species in association with scattered distribution of Jarul *(Lagerstroemia speciosa)* and Bhuidumur *(Ficus heterophylla).* Diversity and population were not rich as per information of local people. However the tiny coverage of the swamp forest of this haor supported various wildlife as their dwell and breeding habitats. There was no reedland inside the haor.

Post Project

Swamp forests of this haor have been destroyed due to extension of agricultural practice for more crop production. Cattle grazing is another main cause for the destruction of swamp forest. Yet, there is still some tresses of swamp forest at the peripheral *'kandas'* along the Updakhali River.

(Picture taken October 2017)

Figure 7.3: A Part of Remaining Swamp Forest at the Bank of Updakhali River near Keshobpur Village

Impact

Agriculture extension and cattle grazing caused destruction of swamp forest of this haor. Facilitation of crop production by implementing submergible embankment is indirectly responsible in this regard.

7.6 Ecosystem Goods and Services

Pre Project

Important ecosystem goods are food, fertilizer, medicine, energy, fiber, fuelwood, construction and craft material. On the other hand, the ecosystem services have been divided into four categories on the basis of their nature of functions and they are provisioning, regulating, supporting and cultural services. In this stage, the goods and services had not interrupted by any interventions and these were improved naturally. Seasonal vegetation of floodplains and elevated areas of the haor had a massive contribution to providence of indigenous feeds, medicine, fuelwood for cooking, thatch materials for house making, and fertilizers for the crop production. Abundantly grown Dhol Kolmi was supported as a staple amount of fuelwood to the local inhabitants. Fishes from beels and floodplains was the major source of protein to the local people. Food, medicinal plants and genetic resources of the flora and fauna are considering the **provisioning services** in this area had been standard before implementation of the interventions. There were vast **Regulating services** such as climatic condition were good because of vast coverage of natural vegetation as well as cultivated vegetation on settlement and cropfields. Wetlands were functioning well due to possessed required depth and good water quality.

Figure 7.4: Different Ecosystem Goods and Services of the Haor

Post Project

Services have been changed with changing of functionality of wetlands as this area is mostly depending on wetland ecosystems. The supporting services of wetland have interrupted due to increase siltation. The provisioning services as well as food production have boosted up in the case of cultivated varieties with growing of food demand for human. But food production from natural vegetation has been decreased day by day due to landuse change for crop cultivation. The **regulating services** are as usual over the time.

Impact

Ecosystem services have been changed over the time for changes of landuse and increase siltation in wetland area. Intervention is positively responsible for boosting up crop production.

8. Socio-economic Conditions

8.1 Introduction

The Haor system provides a wide range of economic and non-economic benefits to the local people as well as to the people of Bangladesh at large. These include benefits in terms of rice production, fish production, cattle and buffalo rearing, duck rearing, collection of reeds and grasses, collection of aquatic and other plants. This study was conducted at Updakhali Haor area. The socio–economic picture has been explored in this section to understand both before and after project people’s condition using both primary and secondary data in relation to the objectives of the study.

8.2 Location and Population

The Updakhali Haor area is mostly covered by 3 unions (Kalmakanda, Bara Kharpan and Pogla) of Kalmakanda Upazila and Madhyanagar and Paikurati Union of Dharmapasha Upazila of Netrokona and Shunamganj district respectively. A Mouza of Chhiram Union of Barhatta Upazila of Netrokona distrct is also into this haor area.

The study area has a total estimated population of 73911 at present (2017). Its population was only 61079 at the time of construction of this project by BWDB. Based on population and housing census the number of households, population, density and sex ratio for the year 1991 and 2017 are presented in the following **Table 8.1**.

Table 8.1: Distribution of Population and Household in the Study Area

Time	Household	Population	Sex ratio	Density
Before Intervention (2001)	**12008**	**61079**	**105**	**502**
Present (projected, 2017)	**14782**	**73911**	**99**	**627**

Source: Bangladesh Population and Housing Census 1991 & 2011 and projected up to 2017.

8.3 Livelihood Status

Pre Project

Agriculture was the prime source of livelihood for the majority of population. Majority of the households (about 95%) were directly dependent on agriculture as the main source of income with about 20% on cultivation/share cropping and about 75% as agricultural labourer. Fishery and business were the second dominant occupational group for earning their livelihood (2%). Other sources of income were service and transport.

Post Project

Occupational scenario has been changed in course of time. At present, it is observed that about 85% of the population are directly or indirectly dependent on agriculture. During the field visit it was also found that agriculture is the primary source of livelihood for 10% of the households. Another 45% are employed as wage labourers on other farms and rest 30% of the household are involved both in farming as well as in other occupation like wage labour.

Furthermore, during the field visit it is found that the occupational groups and occupational patterns are characterized by the land holding category and seasonal variation in employment. Normally, the large farmer (3.036 ha and above ha) and medium land owners (1.012 – 3.032

ha) did not engage themselves in any other secondary occupation for their livelihood. But the landless and the small farmers were bound to engage themselves in many other secondary occupations with seasonal changes.

A number of people about 8% have permanently migrated from the area at different parts of the country for better income and livelihood. Besides, there also some seasonal migration was found in the study area both in terms of out migration mainly in garments sector (12%) and occupational migration especially in fishing (20%) due to continuous loss in agriculture. Mainly the agricultural and non-agricultural labourers are these migrants. On the other hand people of the area are gaining their livelihood from business, non-agricultural labour, service and transport.

Impact

Agriculture is the main sources of income so far and the agricultural production is increasing in Updakhali Haor Project area. Income opportunity based on fishing has declined and only some people from fishing community got access only to do work as a seasonal labor in this particular area. Due to leasing arrangements, which are often controlled by local elites, result in highly restricted access to open water fisheries by the poor.

8.4 Accessibility in Education and Health

Pre Project

Health and education services for the people of Updakhali Haor project area were not accessible to all. During the rainy season, primary education was frequently disrupted during floods almost every year. People used boat to go to schools and health clinics while walking was the only choice when boat did not ply. Schools remained closed for 70 days on average every year due to flooding. The school houses were used as flood shelter for the affected people. Students living in distant area usually used to drop their classes due to unsafe communication during monsoon. On the other hand, the flood- induced poverty increased the number of drop-out students in this haor.

Post Project

Health and educational institutions have increased with time and people, especially school going children, have become enthusiastic to go to schools run under different Govt. and NGOs programs. Besides, when the submergible embankments were constructed, local people, school going children, pedestrian, women and other people have been using it as road especially in the dry season. Presently, when some of the locations of the embankments are damaged, people's way to reach to the schools and health institutions are reported to be hampered for a certain period. But in wet season, deferent types of boats are the main sources of transportation for going to school and health center.

Impact

Impact of the construction of Updakhali Haor Project area on literacy and health has been marginal: except for inundation of the embankment for, say 2 months a year, the submergible embankments have been used as road to access schools and clinics for the remaining period. Patients on emergency can be taken to clinics by using local vans or rickshaws along the embankment in dry season when alternative roads are not existing. The indirect benefit to education and health services is the increased affordability of small and medium farm households to avail those services with their increased agricultural and ancillary income due to protected crops and other resources from damage as an effect of flood control and drainage infrastructures.

8.5 Land Price

Pre Project

Before intervention, the land price of this Haor region was minimal and people were not interested to buy land due to regular flash flood and crop damage. It is reported by local people that the price of agricultural land was 4000 to 5,000 Tk per Keyar[1] and Tk.10,000 to Tk.15,000 for homestead land before project.

Post Project

With the project-induced change and autonomous development in the whole Haor region this situation has changed and the land price has increased with the period of time. After the project intervention, the land price has increased due to the increased productivity of land and improved communication system. Though exogenous factors like macroeconomic development and inflation have contributed to raise the land price, people's interest to buy those land is acknowledged to be one of the reasons of rise in land price. Presently, the price of agricultural land per Keyar (30 decimals) is around BDT 15.0 thousand to BDT 20.00 thousand whereas the price of homestead lands learnt as BDT 70 thousand to BDT 80 thousand per Keyar.

Impact

Flash flood protection and enabling environment for HYV rice culture, value of land has appreciated by more than thrice the pre-project price. On an average about tk. 10 thousand has been increased for agricultural lands and tk 50 thousand for homestead lands.

8.6 Agriculture Based Income

Pre Project

Livelihood opportunities for households in the Updakhali Haor Project area were limited and highly seasonal, as they were focused predominantly on agricultural labour associated with the single annual local Boro rice cropping cycle. Fishing was traditionally an important occupation for the people of Haor region. The incidences of livestock husbandry as a livelihood activity in the Haor region were also prominent as their tertiary source of income before the intervention.

Post Project

After project intervention, the income opportunity based on agriculture increased and people got chance to grow more HYV Boro paddy and recruit local labor, generating extra income opportunities for the wage earning households. The scheme area becomes protected from early flash flood due to implementation of the interventions. Additional 13625 ton of crops are being produced in the scheme area due to interventions and higher yield rate of HYV paddy and newly introduced cultivation of HYV Aman.

[1] 1 Keyar = 30 decimals

Following **Table 8.2** shows the agricultural income, based on cropped area and crop production. Based on current production rate (per Ha), agricultural income has been calculated and presented in this table. At present the overall cropped area has decreased but the net production has increased. To calculate the direct financial outcome, the present government procurement rate (tk21400/ton) of paddy has been taken as unit price into consideration. Before the project intervention total value of the produced crop was tk 271.38 million while after the project intervention overall crop production has increased and production value increased to tk 599.97 million.

Table 8.2: Agricultural Income Based on Crop Production

Crop name	Production (tons)		Income (Million BDT)		Net Increased Income
	Pre project	Post project	Pre project	Post project	
Lt. Aman	4,749	927	87.85	17.14	328.59
HYV Aman		6,650	0	119.69	
Hybrid Boro		855	0	15.43	
HYV Boro	4,945	21,776	7.41	429.59	
Local Boro	9,441	1,073	174.66	15.89	
Robi crops	3,840	5,320	1.44	2.20	
Total			**271.37**	**599.97**	

Source: Field data, 2017 through FGD, KII, and Informal Interview

After project intervention, the income opportunity based on agriculture has increased and people have got favorable agronomic environment to grow HYV paddy and recruit local labor generating extra income opportunities for the wage earning households. People who have more land can grow more crop after the project.

Impact

Regular flooding and water logging condition especially during the time of *Chaitra* and *Baishakh* (Bengali Month) inflicted damage to agricultural production before the project and, therefore, the income opportunity of agricultural households was low. The opportunities for agricultural labor were also limited before project condition.

After project intervention, people got enabling environment to grow more paddy and recruit local labor generating extra income opportunities. So the income opportunity based on agriculture has increased up to BDT 87.49 million with project. People who have more land can grow more production during the project period.

8.7 Income of Agricultural Wage Labor

Pre Project

It was found that before the project intervention, net demand for labor per ha near about 173 person for Local Boro and B. Aman and a total number of 11.79 lac man days were needed. About 55% labor used to migrate from outside the locality.

Post Project

But after the project intervention the crop variety has changed. As a result, the labour requirement has increased due to improved cultural practices (transplanting, using fertilizers, pesticides etc.) From the field investigation and CEGIS estimation it has observed that on an average a total number of 14.70 lac man days is needed annually. At present most of the labors are from the locality but still now on an average 20% labors come from outside. For calculating the labours income the present wage rate (tk 300/day) is considered per day.

Table 8.3: Agricultural Labor Demand and Labor Based Income (Project level)

Crop name	Labor/Ha		Total Man days		Income (BDT/Million)		Net Increased Income (BDT Million)
	Pre project	Post project	Pre project	Post project	Pre project	Post project	
Lt. Aman	170	150	416160	61500	124.848	18.45	87.49
HYV Aman		155	0	319300	0	95.79	
Hybrid Boro		170	0	30600	0	9.18	
HYV Boro		160	0	942880	0	282.864	
Local Boro	170	165	705500	51810	211.65	15.543	
Robi crops	180	170	57600	64600	17.28	19.38	
Total			**1179260**	**1470690**	**353.77**	**441.20**	

Source: Field data, 2017 through FGD, KII, and Informal Interview

Impact

Regular flooding and water logging condition especially during the time of *Chaitra* and *Baishakh* (Bengali Month) inflicted damage to agricultural production before the project and, therefore, the income opportunity of agricultural households declined. The opportunities for agricultural labor were also limited during the time of before project condition.

After project intervention, people got enabling environment to grow more paddy and recruit local labor generating extra income opportunities. So the income opportunity based on agriculture has increased with project. People who have more land can grow more production during the project period.

8.8 Labor and Seasonal Migration

Pre Project

People did not get more access to do other works than to agriculture. People from different regions came to join as work force for crop harvesting and fishing. The intensity to come during that period was significant and people's demand specific labors within the haor area were not adequate to assist their agricultural production. The technological innovation for agricultural production was not significant at that period. Use of transplantation system, pesticides, insecticides, fertilizers etc. were almost unknown. It was found that net demand for labor per ha was roughly 171 and 55% of the labor came from outside than the locality.

Post Project

After the project intervention, as the agricultural production has increased, livelihood opportunity for wage labour has increased too. The net demand for agricultural labor (having with technological innovation) is roughly 161 per ha. So, average labour input has decreased due to technological innovation but the net increase of 8% labour of the study area has enhanced opportunity for their livelihoods. Now about 25% labours migrate from other regions.

In a cropping season when the working opportunities are available, wage labourers rarely migrate outside of their habitat and instead in-migration takes place during that time. During last ten years people have been facing regular damage due to flood and water logging, in this way, people who were dependent on agriculture for livelihood were forced to migrate to neighboring districts for better livelihood. During the flash flood, people of this Updakhali Haor Project area try to find other opportunity to render labour as motor driver, garment workers, rickshaw puller in Netrokona, Mymensing and Dhaka city areas.

Impact

As a result of increased income from wage, relatively poor labour households of Updakhali Haor Project area have been able to raise their living standard to some extent. Opportunities of wage income from beyond this haor for those households also have increased due to similar developments in agriculture. Therefore, the net impact of the project on income and living standard of labour households of the Haor is positive.

8.9 Transport and Communication

Pre Project

People mostly used boat during the rainy season, and specific transportations system was not available during that period. People used to go to their desired places on foot in the dry season. The roads for using any kinds of vehicle were not available. Most of the social occasions were held during rainy season only to avail opportunities of using boats.

Post Project

After the period of project intervention, people started to use those submergible embankment as road to go to school, highways, bazaar and health center etc. Though those embankments were not suitable for driving automobiles, people got opportunity to ply with auto rickshaws and bikes during the dry season. But in wet season, boat is the main sources of transport and communication in this region. During last 5 to 10 years, the damage of submergible embankments have left the school going students, pedestrians, children and women with problems to use those embankment even as foot path during the early monsoon period.

Impact

The communication system has become improved as this haor is very close to the Upazila HQ. The BWDB's submersible and compartmental embankments are playing major roles in communication though this is damaged after each flood. Now a days, due to erosion of the embankments, sufferings of the people has become beggar's description. In the wet season, the sufferings increase many times. Poor communication hampers the overall socio-economic activities and suppresses the developments as well. Proper and protected road networks as well as the water way communication are essential to ensure the overall socio-economic development of the haor people.

8.10 Institution and Governance

Pre Project

Bangladesh Water Development Board (BWDB) was responsible for physical implementation of water sector projects in haor region. Of late, Department of Haor and Wetland Development has been created. As apex institutions, these two have been administering all plans and projects in haor region.

Before the project intervention, local government organization like Union Parishad or Thana Parishad existed with mandate to look after haor water resources. Regular inundation by flood waters was almost a regular phenomenon in haor area. Leasing of Jalmahals was the prime activity of those institutions for raising revenue of the government. It was only after BEDB was created that the issues of water development came in.

Post Project

After the project implementation, Water Development Board started to develop, manage and monitor the project activities in Updakhali Haor Project area. Their role for operation and maintenance was regular with the completion of submergible embankments. Presently, it has been found from the consultation with primary stakeholders that those institution are visible only during the period of damage and to monitor the physical condition of those embankments after the flooding condition. According to the local people, the officials from this institution do not consult with the local people for lessening the damaged area of those submergible embankments.

Impact

The presence of BWDB and the Water Management Group has some institutional impact on the beneficiaries of the haor project. Overseeing the operation and maintenance of the infrastructures is the main function of those institutions. But the condition of physical infrastructures of the haor is reported to be running below the desired level.

9. Summary of Impacts

9.1 Summary of Impacts

Indicators	Pre Project	Post Project	Impact
Water Resources			
Flooding	The project area was inundated frequently by flash flood by April and at times in mid-March. Water stayed for about 2-3 months in the project area.	After implementation of the submersible embankment and other structures by BWDB in 2001-2002, entrance of flash flood into the project area got delayed by 15-20 days.	Risk of entrance of flash flood has reduced.
Drainage	Most of the flood water could smoothly be drained out to the peripheral rivers as the area was totally open. Most of the project area got dried up by September.	Drainage of flood water has been impeded due to interventions. Most of the haor area is drained by November.	The drainage of the haor has deteriorated a little bit. It got delayed by 15-20 days than the pre-project condition. Conflict has arisen between the fishers and the farmer's in terms of public cut. The farmers cuts the embankment for quick drainage to undertake cultivation but fishers want to keep water to increase fish production.
Sedimentation	The sediment carried by the flash flood got deposited both in the rivers and haor area. Hence, sedimentation was not that much problem before implementation of the interventions.	Sedimentation has taken place in the rivers, beels and khals over the years. As a result, the bed level of the rivers, beels and khals has risen and conveyance capacity has also been reduced.	Siltation has increased in both the peripheral rivers, internal rivers and khals.
Navigation	There was navigational connectivity between the haor and the peripheral rivers throughout the year. A number of large vessels used to ply in the rivers during monsoon but reduced in the dry period	Navigational connectivity between the haor and the peripheral rivers remains operative during monsoon. Besides, navigation also operates through the breached points and public cuts before repairing in February/March. Moreover, boats can ply within the haor for fishing and other purposes.	The navigational connectivity has not been affected in monsoon but it does not operate during pre-monsoon due to repair of submersible embankment. Navigation in the peripheral rivers has not been affected appreciably.
Land Resources			
Land use	Gross area:8,005 i)NCA :6,811 ii)Others:1,194	Gross area:8,005 i)NCA:6,867 ii)Others:1,138	i)NCA:+56 ii)Others:+56
Land degradation	No	Total sand carpeting: 250 ha	Total sand carpeting: 250 ha

Indicators	Pre Project	Post Project	Impact
		Comes under cultivation: 15 ha Fish: 35 ha Uncultivable: 200 ha	Comes under cultivation: 15 ha Fish: 35 ha Uncultivable: 200 ha
Agriculture Resources			
Cropping intensity (%)	127	133	+6
Cropped area (ha)	Rice: 8,321(HYV Boro: 1,723,Local Boro:4,150) Non Rice:320	Rice: 8,757(Hybrid Boro: 180. HYV Boro: 5,693, Local Boro: 414) Non Rice: 380	Rice:+436 Non Rice: +60
Crop production (ton)	Rice: 19,135 Non Rice: 3,840	Rice: 31,280 , Non Rice: 5,320	Rice:+12,145 Non Rice: +1,480
Crop damage (ton)	Rice: 4,146 Non Rice: 960	Rice: 5,436 Non Rice:760	Rice:+1290 Non Rice: -200
Irrigated area (ha)	Rice: 5,873 Non Rice: 320	Rice: 6,287 Non Rice: 380	Rice:+414 Non Rice: +60
Surface water Irrigation availability	Available	Deficit during month of February to March	Deficit
Agro-chemicals use (ton or kiloliter)	Fertilizers: 760 Pesticides Liquid: 0 Granular: 0	Fertilizers: 2,758 Pesticides Liquid: 6.5 Granular:16	Fertilizers: +1,958 Pesticides Liquid:+6.5 Granular:+16
Livestock Resources			
Livestock population (number)	Cow/Bullock: 8,780 Goat:4,470 Duck:18,000 Chicken:27,580	Cow/Bullock:12,290 Goat:4,580 Duck:19,370 Chicken:36,800	Cow/Bullock:+3,510 Goat:+110 Duck:+1,370 Chicken: +9,220
Fisheries Resources			
Fish habitat area	• Total fish habitat area- 5,691 ha • Habitat area breakdown: ○ Khal- 37 ha ○ Beel-477 ha ○ Floodplain- 5,177 ha	• Total fish habitat area- 5,578 ha, • Habitat area breakdown: ○ Khal- 62 ha ○ Beel- 291 ha ○ Floodplain- 5,219 ha ○ Fish Pond- 5 ha ○ Baor- 1 ha	• Loss of total fish habitat area by 113 ha (Decreased Beel area)
Fish habitat condition	• Habitat quality and suitability condition was in favor of fisheries; • Maintained unregulated ecosystem with better provisioning (i.e., fish) and supporting (i.e., fish nursery and breeding grounds) services like sustainable fisheries.	• Habitat quality and suitability condition becomes little degraded; • Regulated ecosystem with somewhat degraded and unsuitable habitat condition particularly for Beel resident fishes; • Increased pollution load due to intensified Boro cultivation.	• Slightly degraded habitat condition driving towards relatively less sustainable mentioned provisioning and supporting services.
Fish Diversity	• More or less evenly distribution of fish species over the area.	• Abundance of some biologically and commercially important fish species become low or rare locally;	• Little imbalance in fish species distribution over the area; • Vulnerability to Beel resident bentho-

Indicators	Pre Project	Post Project	Impact
		• Population of bentho-pelagic like Notopterus chitala, Labeo nandina, Tor tor, Labeo calbasu, Labeo rohita, etc. and demersal fish species like Clarius batrchus, Channa punctatus, Macrognathus aculeatus, etc. become affected more due to dewatering of Beels and indiscriminate fishing under Beel leasing system; • Increased abundance of SIS fish species.	pelagic and demersal fish species; • Possible inbreeding problem due to increase of culture exotic fish species.
Fish migration	• Unregulated lateral fish migration from river to floodplain and floodplain to river through Khal; • Regulated lateral fish migration from internal Khal to Beel and Beel to Khal by making earthen closure at the mouth of Khals by Beel Leaseholders (LH).	• The scheme is almost fully functional. For this reason, fish migration from river to Beel and Beel to river in the pre-monsoon season is being obstructed due to embankment and water control structures.	• There is significant implication of interventions on fish migration particularly for SIS.
Fish production	• Fish production in 1989 was about 3,677 metric ton.	• Fish production in 2015 was about 3,891 metric ton.	• Overall fish production gain is about 214 metric ton in 2015 compared to production of 1989.
Fishing Appliances	• Sustainable fishing was done using suitable mesh sized fishing gears. • Use of Kona Jal /Mosquito net (small mesh sized net) was not reported. • Fishing pressure at the mouth of the Khals during recession period was very low except leased Beel connecting Khals (only by LH).	• Unsustainable fishing is being done using small mesh sized fishing gears like Kona Jal /Mosquito net (mesh size in mm); • Fishing pressure at the water structure points during recession period is more because of engagement of mass people.	• Increased use of unconventional fishing appliances and thus increased fishing pressure. • Recruitment loss/ stock loss.
Fishers Livelihood	• Commercial fishers were dominant in floodplain fish habitat meaning livelihood fully dependent on fishing. • Fishing people were less.	• Part-time fishers become dominant in floodplain fish habitat meaning carrying livelihood with fishing is not adequate and need other income generating activities. • Fishing people are more.	• Fishing based livelihood of commercial fishers becomes unsustainable due to dominancy of part-time fishers.

Indicators	Pre Project	Post Project	Impact
Fisheries Management	• Beel fishery maintained three-year rotation in harvesting fish; • Fish got more time for propagation and grow up; • Sustainable fishery.	• Beel fishery is being maintained mostly one-year rotation in harvesting fish. • Fish is not getting enough time for propagation and grow up; • Unsustainable fishery.	• Beel fishery is being secured by the scheme though the weak enforcement is not yielding expected benefit.
Ecosystem			
Terrestrial flora	Most of the Indicator species were common	Insignificant change of coverage due to agricultural expansion	Intervention is not responsible
Terrestrial fauna	Status was common for most of the indicator species	Status have changed for habitat disturbance and hunting	Intervention is not responsible
Aquatic flora	Indicator species were common	Status have changed in large river peripheral areas due to habitat destruction by siltation and overfishing	Intervention is not responsible
Aquatic fauna	Indicator species were common	Changes have been occurred for habitat destruction by siltation and anthropogenic pressures	Intervention is not responsible
Swamp Forest and Reedland	Existed tiny portion of swamp forest	Fully destruction of swamp forest for agricultural extension and cattle grazing	Submergible embankment is indirectly responsible in this regard for boosting up crop production
Ecosystem goods and services	Optimum	Reduced supporting and regulating services but increased provisioning services	Submergible embankment is positively responsible for boosting up provisioning services
Socio-economic Conditions			
Employment Opportunity	• Total cropped area was 6811 ha whereas about 11.79 man days labour inputs were needed.	• Total cropped area were 6867 ha where about 14.70 man days labor input were needed	• Additional 2.91 lac labor man days has been employed due to the change in the crop variety and cropping intensity which was possible for intervention. • Employment opportunity has been created during the period of operation and maintenance of those projects in Ubdakhali Haor Project Area.
Agriculture and wage base income	• The total agricultural production value at current price was BDT 271.37 million • The agricultural wage	• The total agricultural production value at current price is BDT 599.97 million • The agricultural wage	• Agricultural production base income was increased due the project intervention up to

Indicators	Pre Project	Post Project	Impact
	base average income was about BDT 353.77 million.	base average income is about BDT 441.20 million	BDT 328.59 million • Agricultural wage labor income increased up to 87.42 during the period of after project condition.
Land Price	• The price of agricultural land was 4000 to 5000 Tk per Keyar and that of homestead land was between BDT 10,000 to 15,000 only	• The price of agricultural land is near to be 15-20 thousand per Keyar whereas the price of 70-80 thousand for homestead lands. •	• Asset value of land has appreciated for all land owning households, making them more credit worthy for more assets to own.
Labr and Seasonal Migration	• The demand for labor per ha near about 173 and maximum labor came from outside than the locality.	• The demand for agricultural labor is near about 161 per ha. But overall labour input has been increased due to the increase of total cropped area (7%).	• Local wage earning households within the project have more livelihood opportunity and their socioeconomic situation has slightly improved with more wage income.
Accessibility in Health and Educational institution	• It was tough to go to schools and health institutions especially in the wet season.	• People started to use the embankments as their way of communication. • With the damage of certain locations of the embankments people felt in-secured to use their way of moving during the rainy season. • School going children sometimes fall in problem in using breached embankments as their way to go to schools.	• The communication system rendered people comfortable at least during dry season but frequent breaches have left them uncertain about using embankment as road as long as these are not submerged.
Institution and Governance	• Local Union Parishad used to manage local water resources and Beels and Haors were managed by Deputy Commissioner at district level.	• The institutions (i.e. WDB) constructed embankments and has been conducting O&M of infrastructures • Local people’s participation in planning and management has been insufficient land hence governance ineffective.	• Institutional presence (of BWDB) is seen but efficiency of flood control system is at the low ebb. • In absence of participatory management body within Haor, the governance position does not turn out meaningful.

10. Environmental Management Plan

10.1 Management Plan

Impact	Mitigation Measures	Enhancement Measures
Flooding	• The submersible embankment should be repaired as per design section within the month of February every year. • Causeway should be constructed at suitable locations to avoid major damage of embankment by public cuts. • Awareness raising program should be carried out against public cut. • The beels, khals and rivers should be dredged/ re-excavated to increase carrying capacity and thereby reducing the impact of flood. • The dredging work should be done in a proper way so that the embankment do not get eroded.	
Drainage	• Internal khals and peripheral rivers should be re-excavated and required number of sluices should be constructed. • Sufficient outlets should be constructed at suitable locations for easy drainage	
Sedimentation	• Sedimentation from the bottom of the regulators and sluices should be removed. • The surrounding rivers and channels should be re-excavated	
Navigation	• The Updakhali River should be dredged regularly. • The outlets should have boat pass facility to maintain navigational connectivity. • Judgment of local stakeholders and fishermen should be considered. • The dredging should be done in a proper way so that the levees of the river do not get eroded.	
Land use(ha)	• Agricultural land graving should be avoided. • Fallow land should be brought under cultivation	-
Decreased cropped area	• Kanda should be utilized for vegetables cultivation.	-

Impact	Mitigation Measures	Enhancement Measures
	• Hydroponics or floating bed vegetables cultivation should be introduced or strengthened. • Medium high and medium low land should be utilized for short duration and submergence tolerant T Aman (BINA dhan7, BINA dhan 11, BINA dhan12 and BINA dhan 13) cultivation. • Flood tolerant submergence variety (BRRI dhan51, BRRI dhan52 and BRRI dhan79may be tested.	
Increased crop production	-	• Crop area should be increased by utilization of fallow land. • Short duration high yielding and hybrid varieties should be developed/introduced/strengthened. • Crop damage should be minimized by timely and proper rehabilitationof water control structures like embankment, regulators, drainage sluices etc.
Decreased irrigated area and Availability of irrigation water	• Regular re-excavation/dredging of the Re-excavation/dredging of Gumai and Updakhali Riverhas to be ensured in order for retention of irrigation water.	• Re-excavation of existing beels and khals should be ensured for retention of irrigation water. • Irrigation water should be ensured by stopping drainout the beels during early dry seasonfor fish harvesting.
Status of livestock/poultry	-	• Grazing area should be increased by utilizingfallow land. • Awareness build up through training • Marketing facilities should be improved. • Availability of high yielding breed should be ensured.
Increased crop damage	• Height of the embankment should be improved as per design level. • Repairing of embankment from Isabpur to Niamatpur and Ganganagar to Bausari, Gobinmdopur was needed. • Height of the embankment should	

Impact	Mitigation Measures	Enhancement Measures
	be improved at all sluice gate. • Overall of the whole embankment is to raise upto 4-5 ft. height through earthwork from existing level of the embankment for saving boro crops. • Height of the embankment should be improved from Isabpur to Ganganagar. • Regular maintenance work is needed on compartmental embankment by BWDB. • Embankment should be repaired during November to December. • Repairing of embankment at vulnerable point from Isabpur to Ganganagar. • Regular dredging of the rivers has to be ensured in order to reduce the intensity of flash flood. • Rehabilitation works should be finished by February • Quality materials should be used for rehabilitation works. • Short duration high yielding or hybrid varieties should be used instead of long duration BRRI dhan29 variety. • Local varieties should be transplanted in the deeper part of the haorarea instead of short height high yielding or hybrid variety.	
Increased use of agro-chemicals	• Farmers should be encouraged to use organic manure to increase soil fertility while avoiding water contamination and reduce the soil fertility. • Farmers should be encouraged to cultivate leguminous crops to enhance the soil quality. • Farmer should be follow modern agricultural technology like Integrated Pest Management/Integrated Crop Management (IPM/ ICM), Good Agricultural Practices (GAP) etc.	
Loss of total fish habitat area by 113 ha	• Re-excavation of beels and khals • Re-establish connectivity of beels with khals • Prohitbit dewatering of perennial beels	
Slightly degraded fish habitat condition driving towards less	• Water holding capacity in the Khals and in some cases in the Beels (i.e.,	

Impact	Mitigation Measures	Enhancement Measures
sustainable provisioning services majorly fisheries.	Kabla Beel, Khara Beel, Khash Beel, Sissani Beel, Atra Beel, Ganuki Beel etc.) should be increased through re-excavation/ dredging; • Maintain minimum 1 m water depth in almost all water bodies during dry season.	
Vulnerability to Beel resident bentho-pelagic and demersal fish species	• Unconventional fishing appliances (i.e., fine meshed gears, dewatering, poisoning, etc.) should be banned; • Should motivate and encourage agriculture sector people for abstaining from use of chemical fertilizers and pesticides for keeping water uncontaminated.	• Beel nursery programme with native fish species should be increased; • Build more sanctuary with the involvement of adjacent fishers community; • The protected area should be guarded especially at night by the professional fishers of adjacent village for facilitating fish species diversity and fish propagation.
Significant implication of interventions on fish migration.	• Increase the conveyance capacity of Khal maintaining minimum 1m depth during dry season; • Fish friendly structures should be implemented for suitable fish passage. • Fishing should be controlled during pre-monsoon and recession period.	• Proper maintenance work should be conducted and monitored by the Project Implementation Committee (PIC). • Monitoring and awareness building activities should be conducted through fishers' communities under the guidance of Upazila Fisheries Officer.
Overall fish production gain is about 214 metric ton in 2015 compared to production of 1989.	-	• Beel fishery should be promoted with three-year rotation; • Beel dewatering should be stopped.
Increased use of unconventional fishing appliances and thus increased fishing pressure.	• Unconventional fishing appliances should be stopped; • Should increase law enforcement for controlling unlawful fishing. • Strong surveillance for maintaining water control structures through controlling fishing.	
Fishing based livelihood of commercial fishers becomes unsustainable due to dominancy of part-time fishers.	• Fishing ban time income generating activities should be promoted. In that case, the fisher's community should be involved in water management group.	
Beel fishery is being secured by the scheme though the weak enforcement is not	• The scheme should be maintained with the coordination of the line agencies.	

Impact	Mitigation Measures	Enhancement Measures
yielding expected benefit.		
Insignificant change of coverage due to agricultural expansion	• Initiate Govt. for conserve respective amount of natural vegetation and reedland in each haor area	• Increase people awareness about wild life conservation
Status have changed for habitat disturbance and hunting	• Control over harvesting of aquatic resources	
Status have changed in large river peripheral areas due to habitat destruction by siltation and overfishing	• Identify the core habitat for the threatened animals and take action to conserve the respective habitats • Initiate commercial production of freshwater snails for meeting up duck feeds	
Fully destruction of swamp forest for agricultural extension and cattle grazing	• Take initiation of swamp tree plantation at larger 'kandas' which are owned by the Government	
Reduced supporting and regulating services but increased provisioning services	• Implement proper landuse planning including natural vegetation and wildlife conservation provision	• Aware local people to optimum use of natural resources
(Livelihood and employment opportunity) New employment opportunity had been created with the increase of agricultural production Employment opportunity has been created during the period of operation and maintenance of those projects in Ubdakhali Haor Project area.	-	• Training would be ensured for the creation of alternative livelihood options • Submergible embankment must be repaired using the local labor • Allocation of all beel /Jall Mohal to the actual fishermen on equity basis • Soft loan would be provided especially in the emergency period (i.e. post flooding condition) • Build up linkage with farmer and national, international traders.
(Agriculture and wage based income) Agricultural production based income increased due the project intervention. Agricultural wage labor income increased with project.	-	• New variety of crops and its profitable production should be ensured among farmers. Appropriate training programs should be initiated for farmers to cope up with the changing climate and technology
(Land Price) The opportunities for agricultural production increased for which the value of agricultural lands is also increasing	-	• Regular Operation and Maintenance (O&M) and riverbank protection work should be continued properly to keep the land optimally productive.
(Labor and Seasonal	-	• Skill development training

Impact	Mitigation Measures	Enhancement Measures
Migration) The demand for skilled and unskilled labor increased during project construction.		program should be initiated for capacity building especially for men and women to enable them to continue with the skill as livelihood opportunity in similar construction works.
(Accessibility to Health and Educational institution) The submergible embankments provided opportunity to be used as road with project intervention. Due to lack of proper maintenance, the damage of the embankments was increased and local people started to face problem to use these embankments as their means of communication	-	• A functional monitoring Committee should be formed in association with BWDB and local people to identify damaged parts of the embankment • Local participation has to be ensured to repair minor damages to embankment.
(Institution and Governance) There is no mechanism to consider local people's ideas and concerns while drawing project operation and maintenance systems. Project people suffer crop loss and other household vulnerabilities. The role of institution to consider public demand in policy, operation and maintenance on the issue of those submergible embankments.	• Quarterly Meeting should be initiated with local water and flood protection committee to understand the gap of institutional policy and governance • A functional Monitoring team should be formed to visit submergible embankments • People's feedback should be taken before the implementation of any kind of policy in relation to new project and maintenance and operation of those submergible embankments.	

Appendix A

Table A-I: Availability of major fish species in Updakhali Haor (but not limited)

Sl. No.	Local Name	Scientific Name	IUCN Status, 2015
1	Ayre	*Sperata aor*	VU
2	Baila	*Glossogobius giurus*	LC
3	Bajari Tengra	*Mystus tengara*	LC
4	Barobaim	*Mastacembalus armatus*	EN
5	Boal	*Walla goattu*	VU
6	Catla	*Catlacatla*	LC
7	Chapila	*Gudusia chapra*	VU
8	Chang	*Chana orientalis*	LC
9	Chital	*Chittala chittala*	EN
10	Darkina	*Esomus dandicus*	LC
11	Ghoinya	*Labeo gonius*	NT
12	Gojar	*Channa marulius*	EN
13	Gutum	*Lepidocephalichthys guntea*	LC
14	Kabashitengra	*Mystus cabasius*	NT
15	Kaikla	*Xenentodon cancila*	LC
16	Kajuli	*Ailia coila*	LC
17	Kalibaus	*Labeo calbasu*	LC
18	Kanipabda	*Ompok bimaculus*	EN
19	Kashkhaira	*Chela laubuca*	LC
20	Katari Chela	*Salmostoma bacaila*	LC
21	Kholisa	*Colisa fasciatus*	-
22	Koi	*Anabas testudineus*	LC
23	Kuchia	*Monopterus cuchia*	VU
24	LalChanda	*Chanda ranga*	-
25	Lalkholisa	*Colisa lalius*	-
26	Magur	*Clarias batrachus*	LC
27	Mrigal	*Cirrhinus mrigala*	NT
28	Mola	*Amblyphayngodon mola*	LC
29	Nandil, Nandi, Nandina	*Labeo nandina*	CR
30	Napit koi	*Badis badis*	NT
31	Potka	*Tetradon cutcutia*	LC
32	Rani	*Botia dario*	EN
32	Rita	*Rita rita*	EN
33	Rui	*Labeo rohita*	LC
34	Shilong	*Silonia silondia*	LC
35	Shing	*Heteropneus fossilies*	LC
36	Shol	*Channa striatus*	LC
37	Tara baim	*Macrognathus aculatus*	NT
38	Tengra	*Mystus vittatus*	LC
39	Tit puti	*Puntius ticto*	LC
40	Veda/ Mani	*Nandus nandus*	NT
	Etc.		

Appendix B

Photo Album

Water Resources

Agriculture Resources

Fisheries Resources

Ecological Resources

Socio-economic Resources

Focused Group Discussion