



**MANAGEMENT OF AQUATIC ECOSYSTEM
THROUGH COMMUNITY HUSBANDRY (MACH)**

*Feasibility Study on Re-establishing Connectivity Between
Kushiyara River and Hail Haor*

Conducted by:



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1. Introduction

1.1 Background

MACH (Management of Aquatic Ecosystem through Community Husbandry) aims at demonstrating community based approaches to sustainable natural resources management in Bangladesh. MACH goal is to "Promote ecologically sound management of floodplain resources (fisheries and other wetland products) for the sustainable supply of food to the poor of Bangladesh". MACH is a GoB project and financed by USAID. Winrock International, CNRS, BCAS and CARITAS are jointly implementing the project in three different floodplain ecosystems namely *Hail Haor* at *Moulvibazar* since March 1999 and *Turag-Bangshai* floodplain at *Gazipur* and *Tangail* district since April 1999 and in *Kongshaw-Malijhi* basin at *Sherpur* since April 2000.

MACH project intends to increase natural production of fish and other aquatic biodiversity through ecological management of wetland habitats with active participation of local user community. The project has provisions for undertaking major physical interventions related to restoration, enhancement and protection of habitats. Reestablishing connectivity among diverse wetland habitats for free movement of fish and other aquatic organisms has given the prime importance in the project. Natural production of fish in the Hail Haor has been reduced substantially due to loss of connectivity with the Kushiya river. MACH project is keen to reestablish the linkage to increase fish yield and species diversity in Hail Haor with out creating any negative impact on local environment and social function.

In order to investigate the present status of the stream networks between the Hail Haor and the Kushiya River and the possibility of reestablishing the connectivity a feasibility study with due emphasis on socio-political and biological issues has been conducted by MACH-CNRS team during September-October 00. This report presents the findings of the feasibility study on reestablishing connectivity between the Hail Haor and the Kushiya River.

1.2 Goal and Objectives

Re-establishing connectivity between Hail Haor and Kushiya River and thereby ensure increased fisheries production and biodiversity in Hail Haor. Following specific objectives has been set:

- i) Explore physical-morphological features of the stream network in between the Kushiya River and the Hail Haor (existing and historical);
- ii) Record views and suggestions of the local community regarding reestablishment of connectivity and likely impact on agriculture, environment and social functions.
- iii) Investigate socioeconomic, biological and technical/engineering feasibility.

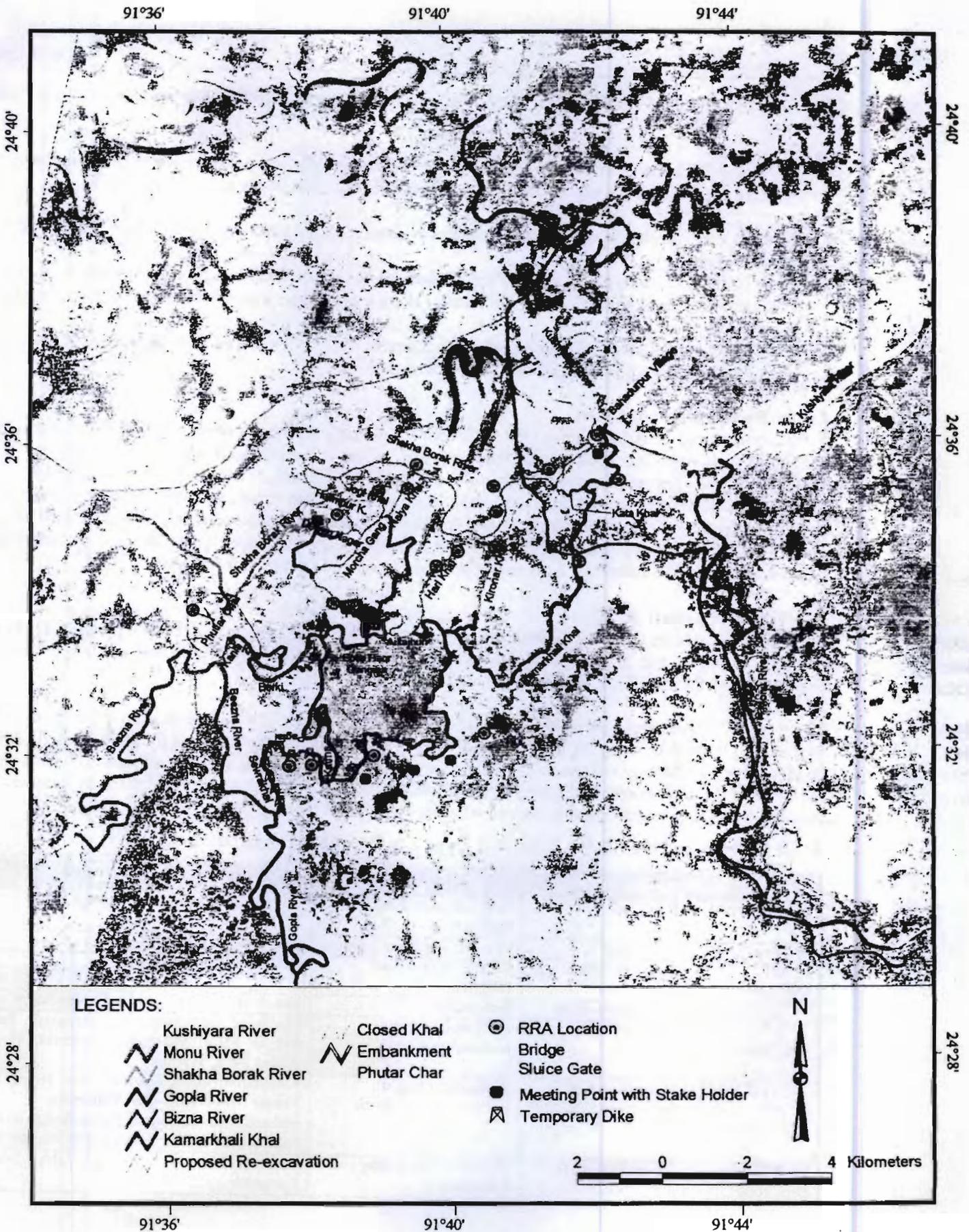
2. Methodology

In investigating the feasibility of reestablishing connectivity between Kushiya River and Hail Haor, a team of 2 members (One engineer and one Socio-economist) worked for two months (September-October 2000). The team was assisted both in the field works and in desk work (planning and mid-term review) by Fisheries Biologist, Site Coordinator, MACH Sreemongal site and Floodplain Ecologist of the MACH-CNRS Team. The field team was also assisted by the Project Hydrologist, MACH. Various tools and approaches were adopted to generate data and information to accomplish the study. The study approaches are briefly presented below:

Review and use of existing data and information

Secondary data sources include BWDB Shakha Borak River Project (Scheme Code # 74200) and Hail Haor Project (Scheme Code # 56800) was collected, reviewed and used in interpreting the findings. In addition, WARPO (Water Resources Planning Organization) national database, LGED maps, Satellite imagery were also used. A detailed discussion in this regard was made with Mr. Shafiqul Islam, Planning Engineer, NWMP, WARPO and Mr. Abdul Baten, Executive Engineer, WARPO. Besides Executive Engineer (Circle-2) and

Figure 1: The Stream Network between Kushiyara River and Hail Haor



SDE, BWDB, Moulovibazar and Mr. Haider Ali, Sluice gate operator and local UP chairmen were also discussed.

National Water Policy emphasizes the importance of the connectivity and provides due attention in the water development plan to keep provisions for free movement of fish¹. The policy emphasized that the:

- Fisheries and wildlife will receive due emphasis in water resource planning in areas where their social impact is high;
- Water bodies like baors, Haors, beels, roadside borrow-pits etc. will as far as possible be reserved for fish production and development. *Perennial links of these water bodies with the rivers will also be properly maintained;*
- Water development plans will not interrupt fish movement and will make adequate provisions in control structures for allowing fish migration and breeding.

Reconnaissance field visits

A team comprising of A.M. Kamal Uddin (fisheries biologist), Zahidur Rahaman (hydrologist) and Lutfar Rahaman (socio-economist) started the field activities paying a reconnaissance visit for two days in early September 2000. The team concentrates on the geographical position and existing geomorphology and hydrology of Kushiyara River, Kamarkhali khal, Shakha Borak River (SBR) with its connecting khals, Boro Haor and Bizna River. The team also provided emphasis on socio-biological scenarios of adjoining villages at present and with case. Reconnaissance field visits, exploring the study area gave the basis for scheduling different methods. The following tools and approaches are used to gather information:

Rapid Rural Appraisal (RRA)

Information related to the investigation was gathered through RRA using a checklist (Appendix 1). In the checklist emphasis was given on the boro crops in the Boro Haor basin. RRA was conducted from 10 September to 9 October 2000. RRA villages are listed in Table 1.

There are 32 villages along both sides of the streams in the study area of which 19 villages are situated on the upstream of Boro Haor along the river and khal's and 9 villages are in the vicinity of the Boro Haor. RRA was conducted in 15 upstream villages and 4 villages around Boro Haor taking alternate villages on both sides of the streams. In an average 10-12 people of different occupation including farmer, fisherman, teacher, UP member, Panchayat member and interested villagers participated in the gathering.

Table 1: Venue and the villages & streams covered in Rapid Rural Appraisal

Date	Stream covered	Villages covered	Venue
10 th Sep.'2000	Hari khal	East Lamua and West Saduhati	On the embankment of Kiraona Khal
11 th Sep.'2000	Naiya khal	Chanpur and Khanjanpur	Shafullah's house, Chandpur
12-13 th Sep.' 2000	Jogi & Halimpur khal	Gorarai, Katarai and Halimpur	Gorarai Bazar (Misilganj)
14 th Sep.'2000	Dewannagar khal	Dewannagar	House of Hazi Farque Mia, Dewan Nagar
17-21 st Sep.'2000	Shakha Borak river	Fatepur, Nasirpur, Mukimpur, Alapur	House of Kamaruddin at Bahadurpur, Fatepur Eidgah Math, Mukimpur Madrasha, House of Abdus Sattar at Alapur
23 rd -24 th Sep & 3 rd - 9 th Oct.'2000	Downstream of Boro Haor	Hazipur, Sadarghat, Daradarpur, and Satak	Kaostogram Bazar, Hazipur Bazar, House of Farque Mia at Sadarghat, Phutarchar embankment, Sadar ghat Bazar, Bridge on the road culvert at Phutarchar, Lugao Primary school.
25-27 th Sep.'2000	Kamarkhali khal	Ghorakhal, Baorbhag and Karimpur	Kamarkhali bridge, Warishullah's house at Karimpur

¹ Article # 4.9, page # 12 of Bangladesh National Water Policy

Stakeholders meeting

During the visit and RRA, stakeholder groups were identified and later on meetings were organized with them at different locations. A total of 5 stakeholder meetings were held where UP Chairmen, members, *panchayat* members, farmers, fishermen, teachers and interested villagers participated. The discussion concentrates on the likely impact of the reestablishing connectivity between the Kushiya River and the Hail Haor.

Physical observation

Physical observation and geo-morphological (feature) characterization of the stream network of the study area were conducted. Physical features included length, width, depth of stream, bank condition, flow pattern, capacity and connectedness of studied streams between the Kushiya River and Bizna River.

Primary Engineering and Hydrological Analysis

The existing and projected (with case) water volume discharge has been calculated on the basis of elevation, flow direction, flow pattern and capacity of the channels. The boro crop of the Boro Haor basin has been the focus of considerations. The time of boro rice harvest has been taken in to consideration and crucial and due attention was also paid. The historical water level during the harvest time, level of inundation in the boro crop field has been taken into consideration to formulate the recommendations. The recommendations have been proposed following the findings of RRA, stakeholder meetings, physical observation and the technical feasibility (Biological, Socioeconomic and engineering) of the proposed interventions. The existing features and probable interventions have been mapped using GIS tools and satellite images (Figure 1).

3. Findings**3.1 The study area**

The area in between Kushiya River (on the east) and the Hail Haor (Bizna River on the west) including the stream networks, settlements and associated floodplain (Boro Haor) has been considered as the study area. The area is located at the north of Hail Haor under Moulovi Bazar Sadar Upazila and some down stream area under Nabiganj Upazila of Habiganj district. The Shakha Borak River (SBR) originated from Kushiya River flowing towards southwestern direction within Moulovi Bazar district. The study concentrates on 23 villages under 4 unions. These are 1 No. Khalilpur union, Moulovi Bazar Sadar (villages: Gorarai, Katarai, Halimpur, Mukimpur, East lamua, Fatepur, Alapur, Nasirpur, Baitakhali (*Dardarpur*), Chandpur and Khanjanpur), 2 No. Monumukh Union, Moulovi Bazar Sadar (Villages: West Shadhuhati, Bahadurpur, Karimpur, Ghorakhal and Baorbagh), 10 No Debpara union, Nabiganj, Habiganj (Sadarghat, Jhitka, Phuterchar, Dewan Nagar, Kaostogram, Hazipur) and Gaznai Union, Nabiganj, Habiganj (Satak village). All the khals that emerged from Shakha Borak are under Moulovi Bazar district. The Kamarkhali khal, originated from the Kushiya River, embanked and connected via sluice gate with the Shakha Borak River is also within the Moulovi Bazar district. The villages adjacent to the Shakha Borak River, Kamarkhali khal, stream networks and the villages in the vicinity of the Boro Haor has been considered as the working villages for the study purpose (Figure 1).

Scenario before loss of connectivity: In the past, Boro Haor area was hydrologically open and connected with the Kushiya River through numbers of Khals. Huge floodwater used to enter into the Haor basin inundating and maintaining ecological virginity resulting in higher fish yield and richer biological diversity. However the settlements and crop of the area were exposed to recurrent damage and the community felt threatened. Main bulk of the floodwater used to enter through the Kamarkhali khal and Shakha Borak River (via Phuterchar and Kironar Khal). In order to protect the settlements and crop of the area the Kamarkhali khal was embanked in 1950s along with the closure of the Kiraona Khal. Closure of these two khals served the purpose (reduce or eliminate flood damage) though a number of small khals were open and carry a minimum flow to the Boro Haor during monsoon (Jogi and Halimpur Khal still carry a little water). Later to stop back flow to the Haor from SBR local people embanked Phutarchar Khal during 1975s. Following the closure of the phuterchar khal the flow of the Shakha Borak River was reduced. Diversion of SBR water to the Kamarkhali Khal started since

1992 after the construction of the Katakhal from SBR to the Kamarkhali. A sluice gate was also built at that time and the elevation of the Katakhal is lower than the Shakha Borak River.

Present scenario: Closure of the Phuterchar Khal, Kironar Khal and diversion of water to the Kamarkhali Khal severely reduced the water flow through the SBR which resulting in gradual silting up of the Shakha Borak and its small distributory khals (to Boro Haor). At present Boro Haor is functionally isolated from the Kushiya River. The people adjoining the Shakha Borak River including fishermen, farmers and overall community are adversely impacted like the river itself. Fishermen could not fish, farmers face scarcity of water in dry season. Navigation problem reduced harvest of fodder resulting in economic loss for the people of the area. It is reported that considerable number of professional fishers changed their profession from fishing to fish trading, rickshaw pulling and even begging.

Hydrology and land elevation: Average ground level elevation of the Shakha Borak at its off take from Kushiya River is 7.6m and Hail Haor average ground elevation is 6.0m. Boro Haor is close to Shakha Borak River and almost in the middle position between Shakha Borak and Hail Haor. Area elevation curve of greater Boro Haor basin has been collected from WARPO and found average bed elevation of Boro Haor at 6.3m (Figure 2.A and 2.B). The water

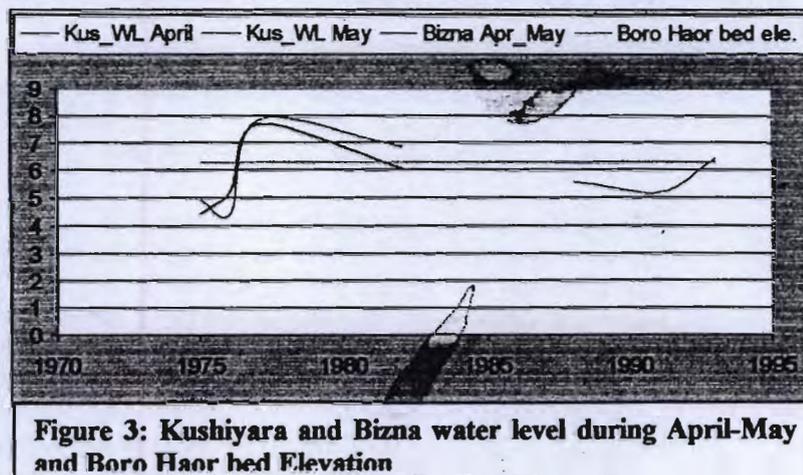


Figure 3: Kushiya and Bizna water level during April-May and Boro Haor bed Elevation

level data on Kushiya River (at Monomukh) has been collected from 1949 to 1982 while data on Bizna River (at Biznee Railway station) from 1988 to 1995 from WARPO. Detail area elevation curve including area identification on image map are enclosed from SBR origin point to Gopla/Bizna river. Figure 3 shows the water level over the years of Kushiya River and Bizna River during critical period (April-May).

3.2 Water ways

The connection between Hail Haor and Kushiya River is largely disrupted. However, whatever connectivity is there, it through the Boro Haor. From the Boro Haor, water flows through several small khals to Bizna River and then to Hail Haor. The Kamarkhali Khal and Shakha Borak River (SBR) both originated from the Kushiya River and feed Boro Haor. The embankment constructed along the bank of the Kushiya River closed the Kamarkhali Khal at its off take and the Shakha Borak River at Phuterchar. The paved road from the Sarker Bazar to Gopla Bazar also closed Kiraona khal, an off take from the SBR to the Boro Haor. From the Boro Haor water flows to the Bizna River and then to Hail Haor (Figure 4).

There are two waterways or routes from the Kushiya to Hail Haor including secondary rivers, stream wetlands in between. The physical condition of each of the ways has been explored. Detail of the physical features of SBR, Kamarkhali Khal and associated streams networks are presented in Appendix 2.

Waterways from the Boro Haor to the Bizna/Gopla river system are still open though there are number of dykes made by the farmers to retain water at local level. The farmers are willing to remove these temporary dykes if the system is open and they could get more water in dry season for irrigation.

In the past, Kamarkhali, Kiraona and Phutarchar khals used to carry the main bulk of water to the Boro Haor from Kushiya River. These khals are closed and channels are at present about 80ft-100ft wide and 10ft-12ft deep. A link canal from the Shakha Borak River to the Kamarkhali Khal was constructed with a water regulating structure in 1992 by the BWDB. The regulator remains closed during monsoon (the fish recruitment period) to save the boro rice. During the study period (5th September 2000 to 9th October 2000) Kamarkhali



Figure: 2.A Box shows the location of Shakha Borak, Kushiara offtake to the end point at Boro Haor.

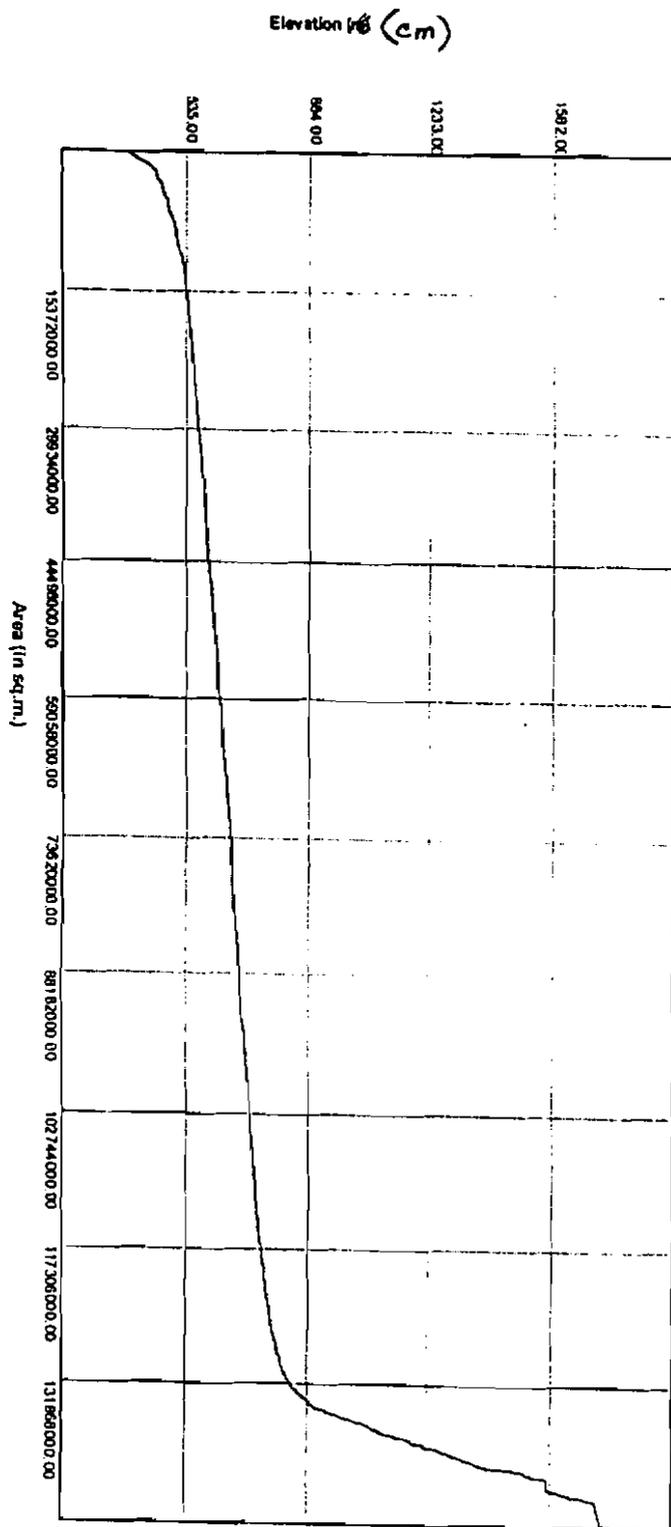


Figure: 2.B Area-Elevation curve for Box area (2.A)

Khal was found flowing, receiving water from the Shakha Borak through Katakhal as the sluice gate was open. The Katakhal is deeper than the Shakha Borak River and when sluice gate is open more water flows to the Kamarkhali khal than the Shakha Borak River (water from SBR diverted to Kamarkhali Khal through the Katakhal and the regulator).

Besides, there are several khals viz. Jogi khal, Halimpur khal, Naiya khal, Dewan Nagar khal originating from SBR and all the khals join the Morcha gaang. The embankments or the road (Sarker Bazar to Gopla Bazar) did not close these khals, therefore the water were flowing through these khals. Box culverts at the mouth of these khals on the paved road reveal this fact. The invert levels of box culverts were observed at two feet lower than the khal bed. It again proves that the intention was to remain these khals open for maintaining flow. After the closure of the Shakha Borak River at the Phuterchar point, the river became less flowing and ultimately silting up and raising the bed level. Consequently, the off take of these khals originating from the SBR got silted up and reduced the capacity of these khals. As a result, when the water level in the Shakha Borak raises during monsoon, the connecting khals could not carry the volume of water and over spills. Hari khal originating from the Shakha Borak River joins the Ailtajuri Khal (Boro Haor) is an example of closing the mouth by the community. The Shakha Borak River at Phutarchar point was closed by cross-embankment decade's back and the water flowing through is forced to Morcha gaang. The paved road from Sarker Bazar to Gopla Bazar closed the Kironar Khal and there was no box culvert at the off take. Three khals named Gopi Khal, Teli khal and Baitakhali khal originating from SBR are now completely dead due to siltation and encroachment. It is not possible to reopen these khals.

3.3 Potential Routes

Out of 10 connecting khals from the Shakha Borak River to the Boro Haor, two khals (Jogi Khal and Nayia Khal) are still flowing with minimum flow and three others (Hari khal, Dewan Nagar khal, Halimpur khal) have been silted up due to less flow of water through Shakha Borak. Kiraona and Phutarchar khal were closed by the downstream people decades back to protect their crop. Paved road, mosque and settlements totally eliminated the possibility of reopening of these two khals. Gopi, Teli and Baitha khals are dead. The possibility of desilting and thereby enhancing and establishing flow exist for *five khals* which are Jogi Khal, Halimpur Khal, Naiya khal, Hari khal and Dewan Nagar khal. All these khals are originated from Shakha Borak River and fall in to the Boro Haor (Figure 4).

Compared to the closed and larger khals (e.g. Kirona khal, Kamarkhali khal and Phutarchar khal), the openable five khals are tiny and would have minimum water flow to Boro Haor. There are two potential routes through which water flow to Bizna River through Boro Haor. The routes are:

Route # 1: Shaka Borak Route: Among the five openable khals originating from Shaka Borak River, water from four khals (Naiya khal, Jogi khal, Halimpur khal and Dewan Nagar khal) flow through Morcha gaang to Boro Haor (Fenlai Beel then to Barki Beel). Then the water flows through Barki Khal to Kanlakhai khal and then finally to Bizna River.

Route # 2: Kamarkhali Khal Route: There is no direct connection of Kamarkhali with Kushiya river as the off take is closed long back. Now water from the Kushiya River enters in to the Shakha Borak River and then flows to Kamarkhali Khal through Katakhal and sluice gate. Then water flows to Ailtajuri Khal and then to Boro Haor. Before falling to Boro Haor, Ailtajuri Khal receives water from Shakha Borak River through another khal named Hari Khal. Then the water flows through three beels in Boro Haor (viz. Katma Beel, Pagla Beel and Sewrakhai Beel) and finally to Bizna River.

Both the channels are observed 60-70 ft wide and water depth in these khals was observed 10-12 ft. during field visit (September-October 2000). The channel bed is found 6 ft deeper than the bed level of Boro Haor. If these khals were rehabilitated at different desired depths, there would be increased water flow in the khals from Kushiya River. This enhanced water flow would allow higher volume of water ingress in the Boro Haor and thereby to Bizna and Hail Haor. It is assumed that this increased ingress of water from Kushiya in

the system would facilitate immigration of fish from Kushiyara River to Boro Haor and Hail Haor. However, fisheries benefit would be higher and readily measurable in Boro Haor than in the Hail Haor, as the water would first enter in to Boro Haor from Kushiyara River.

3.4 Hydrological Analysis

In order to bring water from the Shakha Borak to the Boro Haor and then to Hail Haor, the Shakha Borak needs to be re-excavated to certain extent and a maximum net depth of 4 ft has been considered. After excavation an estimated volume of 1,018,656 Cum/day (April/May) of water would enter in to the Shakha Borak River.

The potential khals those could be re-excavated, a maximum top width of 12ft-15ft and maximum 3ft net depth will be possible to re-excavate. Total design depth of the khal from the original ground level is 6.75ft. Average net depth of 2.75ft is considered. After re-excavation of five potential khals, a cumulative volume of 954,720 Cum/day of water would pass through these khals to the Boro Haor. A volume of 1,018,656 Cum/day of water which will enter in to Shakha Borak, by 5 khals total 1,003,104 Cum/day volume of water will pass in to Boro Haor and the rest (63,936 cum) water will run towards Mora gang then Meghna. Area of

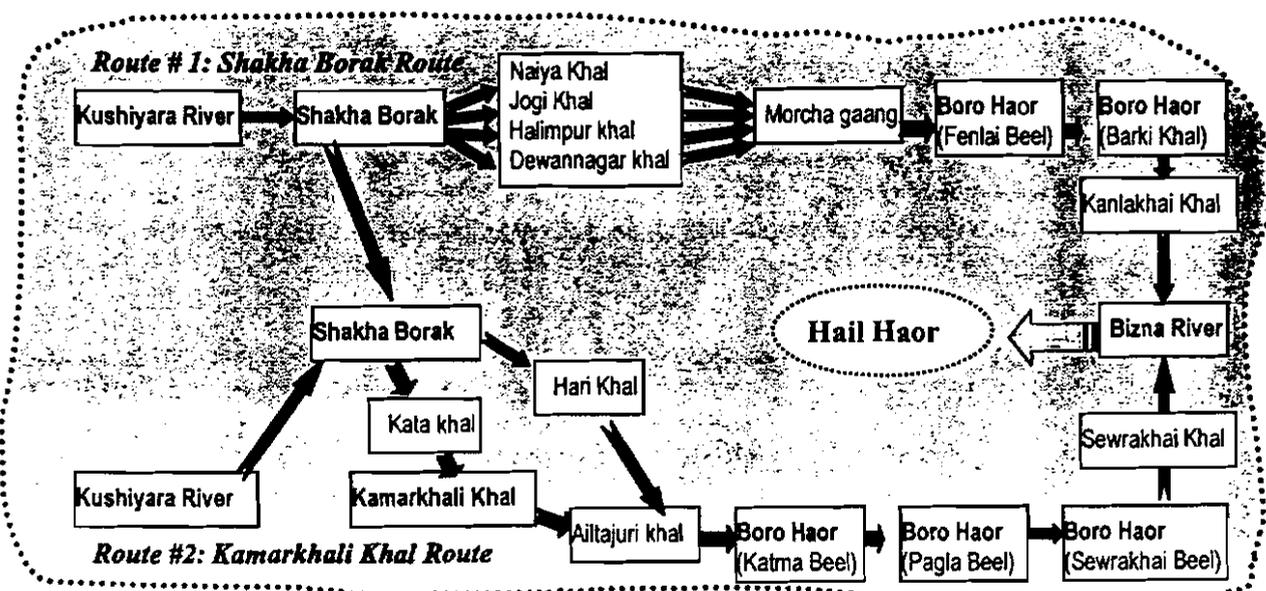


Figure 4: The waterways and Potential Routes from Kushiyara River to the Hail Haor

Boro Haor is 4520 ha (as per report of BWDB) i.e. 45,200,000 Sqm. Considering no discharge through Bizna, 0.022 meter ~ 1inch water would rise in Boro Haor

The connecting channel between Boro Haor and Bizna River is 6ft. down from the Boro Haor bed level. Total length of the channel is approximately 9,000m, average width is 23m and depth is 1.8m. So this channel can hold 372,600 Cum of water and later the water level seems to be at the same level of Boro Haor. So the additional water will affect on Boro Haor by 1/2 inch per day if there is no discharge through Bizna. Detail hydrological analysis is given in Appendix 3.

Presently Bizna River discharges 22,548,065 cum/day (measured on Mid September 2000). So after implementation of proposed interventions (reexcavation of mentioned khals), an additional water volume of 1,003,104 cum/day will enter in to Bizna River, which is 1/23th of existing capacity of Bizna. From Boro Haor to Bizna there is no dike/embankment or sluice gate. Presently, water of Boro Haor discharges through Bizna River and it is logically expected that the additional water would be discharged through the Bizna without affecting the boro rice in Boro Haor basin (Figure 3).

3.5 Views of the Community

A total of 168 participants of different occupations from 19 villages took part in discussion during RRA exercises. Discussion covered wide range of ecological, socio-political and natural resources management aspects. The RRA sessions were planned to cover the streams and adjacent villages within the study area (Table 2). Site wise detail findings of the RRA are given in Appendix-4.

The farmers start cultivating land soon after recession of floodwater for boro rice (both HYV & local variety) along side the Boro Haor. They prepare seedbed in November/December, transplant in December/January and harvest in April/May. Though the yield of boro (HYV) is higher than the local variety, farmers prefer local boro with a view to avoid inundation by early floods. Farmers having land on higher elevation adjoining the Boro Haor cultivate HYV boro rice.

Historically, the people of *villages located upstream of Boro Haor (higher elevation)* along side the khals used to produce diversified crops (e.g. Aus, Amon, Boro, Jute, Wheat) in different seasons and enjoyed better production before the closure of the khal. Free flow of water from the Shakha Borak River facilitated agriculture production as well as fisheries. Navigation supported better marketing, farming, cattle rearing and other household works.

The farmers lost boro crops twice during the last five years due to early flood. In the dry season, no crop could be grown due to scarcity of water in the higher area. The people extracts aquatic vegetation of less quantity. None are engaged in stocking fish or involve in fish culture activities. They believe that the natural fish production has been reduced substantially due to loss of connectivity with the Kushiya River. Furthermore, the Boro Haor are leased out to a group of affluent section resulting in exclusion of traditional or subsistence fishing.

The community (farmers and fishers) of upstream villages (15 villages) are in favor of reestablishing the connectivity. They believe that the connectivity would enhance agriculture, fisheries, navigation and bring overall environmental improvement. They made it clear that the Harikhal, Nayia khal, Jogi Khal, Halimpur khal and Dewan Nagar khal were not closed to save the boro crop of the Haor basin rather these khals were kept open being silted up over time due to inadequate flow in the Shakha Borak River.

Community at Boro Haor vicinity villages (low elevation) is (4 villages) also in favor of restoring the connectivity with control structure and demanded a sluice gate on the Shakha Borak River with proper community management. They also proposed de-siltation of Gopla and Bizna River wherever necessary for smooth discharge of floodwater.

Reestablished connectivity would benefit villagers of 22 upstream villages. Approximately 14,250 people would be benefited. The fisher dwelling in the Boro Haor vicinity villages would be benefited so as the fisheries. The farmers of the lower basin would also be benefited if boro crop were protected. Detail RRA findings for each session are attached (Appendix 4).

Table 2: Matrix showing the problems and probable solution from RRA sessions at different locations

Name of stream & Rivers Covered	Village Covered	No. of participants	Participant's occupation	Problems Identified	Possible Solution
Jogi & Halimpur Khal	03	21	Teacher, farmer, fishermen, doctor, service holder, traders, UP chairmen and member, daily laborer, student, Imam.	Less crop production due to scarcity of water in dry season. Navigation problem. Reduction of natural fish production and species diversity	Re-establish connectivity between the Kushiya and the Boro Haor
Naiya Khal	02	15			
Hari Khal	02	11			
Shakha Borak	04	47			
Boro Haor vicinity villages	04	42			
Dewannagar khal	01	10			
Kamarkhali khal	03	22			

A total of 5 discussion meetings were conducted in Bahadurpur, Phutarchar, Kaostogram, Sadarghat and Jhitka village where a total of 51 local people of different occupations including UP chairman, UP members, teachers participated. Mr Hadi Gaji (Ex. UP Chairman), key person to make the embankment on Kamarkhali khal, Kiraona khal and Phutarchar khal was present in one of the meetings where Mr. Abul Kalam, present UP Chairman of Debpara Union Parishad was also present.

People had lively discussion in the meetings focussing the issue of reestablishing connectivity. They are well aware of the fact that following the closure, over all productivity of the area including fish and other aquatic products has been reduced substantially. They believe that productivity and biodiversity could be regained through reestablishing the connectivity. The agriculture in the higher elevation would also be benefited. People of 23 higher elevation villages showed intense urge for the reconnection, mentioning that it is their necessity and promised to extend all out co-operation during implementation.

The participants gave their farm support for reestablishing connectivity between the Kushiya and the Boro Haor and expressed their interest in taking part in designing, implementing, and monitoring of the interventions. ~~The participants expressed frustration regarding fate of the implementation as they experienced lots of studies but no implementation or follows up actions.~~ They showed their interest in the issue and told that ~~the community of the area would be benefited if the connectivity is established but they suggested keeping a means to control the floodwater.~~

4. Conclusion and Recommendations

Boro Haor were open to Kushiya River before construction of Kamarkhali embankment, paved road between Sarker Bazar and Gopla Bazar and the closure of Phuterchar khal. Main bulk of water used to enter through Kamarkhali, Kironar khal and Phuterchar khal. Despite increased fisheries production, floodwater often caused damage to crops and settlement to varying degrees. To save the area from flooding, these khals were closed. These three khals can not be reopen as permanent establishments (viz. roads, mosque, and dykes) are built on the khals. On the other hand reopening of these khals would have likely adverse impact on the area as before. *It can be concluded that the connectivity can not be established in full as was before.*

However, Jogi khal, Halimpur khal, Dewan Nagar khal, Hari khal, Naiya khal were not closed but silted over time due to low flow through the Shakha Borak River. At present Jogi khal and Halimpur Khal carry little water to the Boro Haor. The carrying capacity of these two khals could be increased through desiltation. Besides, Dewan Nagar khal, Hari khal, Nayia khal can be desilted to have increased flow. *Cumulative flow through these five khals will still be minimal but will facilitate the migration of fish and other aquatic organisms to the Boro Haor and Hail Haor.*

The land elevation of the Shakha Borak River off take point, Boro Haor and Bizna point and Water level at Kushiya River and Bizna river and the carrying capacity of Bizna River reveals that the volume of water would enter through the proposed desilted khals would be discharged through Bizna River without hampering the boro rice.

The upper elevation villagers (23 villages) demanded reopening and the Boro Haor vicinity villagers (9 villages) showed their interest to reopen subject to keep provision for control on floodwater. The villagers are interested to take part in the designing, planning, implementing the interventions related to restoring the connectivity. Estimated quantity of earth to be removed from 5 khals including SBR is shown in Appendix 5.

Based on the findings it is concluded that there exist potential for restoring and enhancing connectivity between Kushiya River and Hail Haor. To this end, detailed PAPD (Participatory Action Plan Development) workshops with the community need to be conducted. Besides, an engineering feasibility should also be conducted to assess the likely impact of rehabilitated khals on local environment. Based on the findings of PAPD and engineering feasibility, detailed Participatory Resource Management and Enhancement Plan can be developed for the area.

RRA Checklist

- Name of Village, Mouza, Union, Upazila and District
- Total number of households in this village and occupation by categories
- Name and condition of connecting khal's/River/Other channels in the area
- Water flow condition in dry and in the wet season with inundation extent and duration
- Water use and availability in dry and wet season
- Regarding Fish, Aquatic Vegetation, Wildlife, Birds, Fish stock or Fish culture (if any) reflecting condition on pre-flood and post-flood or before and after embankment and sluice gate.
- Cropping pattern in the higher elevation and around the Boro Haor and adjacent low lying areas
- Crop damage by season and reasons for damage
- Owner of adjacent land of the channels and land use pattern
- Adverse and beneficial effect khal/river/other channel
- Quantity of fish used to get when the channel was open and active and the quantity of fish are available now
- Physical condition of khal/river/other channel (width, depth, water flow) including water stagnation at points
- Reasons for non-function of any khal/river/other channel
- Soil type in the area
- Any connection with bridge/culvert with locations and condition of bridges/culverts (whether functional)
- Ownership of khals, any leasing for fishing or other use
- Reasons for siltation of existing khals and rivers in the area, any re-excavation was done by any agencies, individuals in the past with reasons
- Likely social conflicts may arise if this khal/river/other channel is rehabilitated
- Likely impact of khal rehabilitation on their local environment and social functions
- Views and suggestion of the community regarding reestablishing connectivity between Kushiayara River with Bizna River

Detail physical features of the streams and rivers between Kushiyara River and Hail Haor

Shakha Borak River (SBR)

Overview: Once upon a time Borak River was connected with Kushiyara River. Overtime the Borak River become isolated from Kushiyara River due to sedimentation at the off take of Borak River. Later on a new spill channel created naturally from Kushiyara River to the east side of former Borak off take and therefore the Borak was reconnected with the Kushiyara River. After reconnection, this river is called as Shakha Borak River (SBR), flows toward Mora Gang, and then towards Meghna River. Presently the linkage between the SBR and Bizna River is no longer existing due to sediment deposition and localized development activities. An embankment was made on the connecting point between SBR and Bizna River located at the Phutarchar village. River reaches adjacent to the closure has been silted up and most of the river reach of this area has been encroached by the local people.

Local community reported that the SBR was originated from the Kushiyara River around 100 year's back. During that time width of the river was about 300 ft and depth was about 20 ft that could drain huge floodwater. Local people also reported that building sluice gate is the cause of siltation and consequent raising of the riverbed.

Physical Features: The length of SBR from the connecting point of Kushiyara to Dewannagar village is approximately 14.5 km. The width of the river varies at different points, at the off take it is 120 ft and then gradually decreases to 40 ft at Dewannagar point. The velocity of flowing water at the connecting point of SBR was measured at 120 ft/minute during mid September 2000. SBR is connected with Kamarkhali khal through Katakhal, about 2 km south from the Borak-Kushiyara confluence. A sluice gate was constructed on the Katakhal in 1992 after excavation of Katakhal. The sluice gate was constructed to control water to protect *boro* rice of the Boro Haor basin. Water through Katakhal was found flowing at 80 ft/min while the gate was open and the remaining water being flown through the SBR.

Kata khal's connecting point is 3 ft deeper than the SBR bed and the SBR has few outlets at the downstream with very little water course results into severe siltation in river bed. Aquatic weed in the khal bed is another reason for siltation (obstruct water flow and accelerates siltation). The homestead wastage and eroded soil from croplands and upper catchment also are raising the bed of the river. The water depth of SBR at the mouth has been found very high (12 ft) compared to the downstream (2-7 ft). Siltation at the downstream is higher probably due to closing of several khals. The terrace has been found about 2 ft high from the water level during September 2000. From Sarker Bazar Bridge to Dewannagar village, the water depth ranges from 6.5 ft to 4.5 ft where the terrace is 1.5 ft high from the water level (September 2000). The soil texture of the riverbed is silty clay. It is relevant to mention that the bed of SBR river at the connecting point is found 7 ft higher than the Kushiyara water level during dry season when SBR found completely dry.

There were several khals from the SBR to the Boro Haor. A total of ten khals have been identified, which are Hari Khal, Naiya khal, Jogi khal, Halimpur khal, Dewan nagar Khal, Kironal khal, Phutarchar khal, Gopi khal, Teli khal and Baitha khali khal. Kiraona khal used to carry huge water and was closed by the embankments leaving no option for water flowing (i.e. there is no box culverts or sluice gate). The Phutarchar khal and Baithakhali khal was also closed totally. Presently, Jogi khal and Halimpur khal are carrying little water to the Boro Haor basin from SBR. All other khals are silted up due to various natural and anthropogenic causes. Among the mentioned 10 khals, there are 5 khals that could be considered as potential for rehabilitation and other 5 khals are either closed permanently or dead and not possible for rehabilitation.

Potential Khals for desiltation

The Shakha Borak River is the sources of water for Hari khal, Naiya khal, Jogi khal, Halimpur khal and Dewannagar khal. Out of these five khals, Harikhal joins Ailtajuri khal and other four khals join Morcha gaang of Boro Haor basin and then flow to the Bizna River through Boro Haor system.

Hari Khal

Physical Features: Hari khal originated from the SBR and passes through West Saduhati and East Lamua villages, and join Ailtajuri khal of Boro Haor basin. There is Herringbone Brick (HB) road along one side of the khal and earthen road on another side of the approximately 3 km long khal. The HB road is terminated near Sarkun Mia's house at Pong Madhpur village. There is another box culvert near the middle point of the khal and a total of 6 dykes to cross the khal by the villagers. There is no water flow but water logging has been observed during the field work in September 2000. The terrace level varies from off take to Ailtajuri point. The elevation of the khal decreases gradually. The existing depth of the khal is found 4ft to 5ft with minimum depth near 2/3rd-length point of the khal. The width of the khal also varies in different places. The width of the khal from the starting to middle point is 15 ft and decreases to 10-ft even 8 ft towards the end. Last 1km of the khal is wide, as there is cropland along both sides of the khal. Bank of the khal is *khas* but as usual, encroached by the local people.

A box culvert on the paved road from Sarker Bazar to Gopla Bazar along the SBR maintained the flow before the closure of the off take. While the Borak became less flowing, the Hari khal got silted up resulting reduced capacity and over spilling the bank. To remove this problem, community embanked the off take of the khal. During the RRA and meetings, the community demanded desiltation of the khal and removal of the embankment from the mouth of the Khal.

Naiya Khal

Physical Features: Naiya khal originating from SBR passes through Chanpur and Khanjanpur village to Morcha Gaang of Boro Haor. Naiya khal was re-excavated to a width of 16 ft and 7 ft deep about 60-70 years back as reported by the villagers. Road from Sarkar Bazar to Gopla Bazar is around 1,500 ft south of this khal and has a box culvert while the khal crosses the road. There is earthen road along both sides of the khal up to first meander of the khal.

Total length of this khal is about 2 km. There are six cross dykes made by the local people for easy movement from one side to another. Among the six cross dykes, five are in between the mouth and paved road. The Muslim community requested to build at least one culvert on the khal for easier movement from one side to another. Water can not pass through this khal and filling the khal bed by wastes coming from settlements.

Existing water depth of the khal varies from 8 inch to 2.5 ft while the width varies from 8 ft to 12 ft at different section of the khal. Terrace is 2 ft high from the water level (September 2000). There is no water flow observed during the fieldwork. Local people have encroached the adjacent land of this khal and using for settlement, plantation and agricultural purposes. During RRA local people ensured that the encroachers would leave the khas land in case of re-excavation of khal.

Jogi Khal

Physical Features: Jogi khal originated from SBR flowing in a zigzag motion approximately 1.5 km through Gorarai and Katarai village and meet to Morcha Gang. There are 3 box culverts on the khal. Water flow (25 ft/minute) has been observed during field visit (September 2000). Width of this khal varies in different places from 8 ft to 20 ft while depth varies from 2- 3.5 ft. The terrace of khal found 2 ft high from the water level.

Community people reported that that initially the width and depth of the khal were 16 ft and 7 ft respectively. Initially the khal joins with Buri beel, which met with Morcha Gang. But presently the khal directly meets with Morcha Gang as Buri beel has been converted to homestead land. People made a new khal of 400 ft length, 8ft width and 2 ft depth by excavating besides their houses. People ensured that they would cooperate in khal re-excavation even they would prefer to back out from encroached land, if needed.

Halimpur Khal

Physical Features: Originating from Shakha Borak, Halimpur khal flows through Halimpur village and Letua beel falling in to Morcha Gang. There is no water flow through this khal except little stagnant water drained out from homestead land. Width and depth found varies in different places. Width ranges from 3-10 ft while depth has been found from 1.5 to 4 ft. There is a box culvert on this khal.

There is another connected khal namely Letua Khara between Letua Beel and Morcha Gang. The length of this khara is about 2000 ft, width 12 ft and depth 4 ft. 45 ft/min water velocity has been found during visiting the area.

Dewan nagar Khal

Physical Features: Dewannagar khal/ Chogar khal/ Raba khal flows from Shakha Borak to Morcha Gang through the Dewannagar village. The straight khal is interrupted by homestead construction and diverted to an another course, which also falls into Morcha gaang. Total length of this khal is about 1.5 km. Width found to be varies from 5 to 8 ft while depth is about 1 ft. Water logging is observed in the khal. There is an earth road beside this khal started from the metal road.

Morcha Gang

Physical Features: Naiya khal, Jogi khal, Halimpur khal and Dewannagar khal meet with Morcha gang directly or indirectly. Morcha gang is draining to Bizna River through the Boro Haor. The length of Morcha gang from Naiya khal to Fenlai Beel is about 4 km. Width of this channel varies from 60 ft to 80 ft while depth is around 5 ft. Water flow is found very minimum in this channel because the connectivity by different khals has mostly been silted up.

Physical features of water ways from "Morcha gaang to Boro Haor then Bizna through Barki khal & Kanlakhai khal"

As mentioned earlier Morcha gaang falls in Boro Haor. Then another khal, namely Boro Haorer gangina flows from Boro Haor to Barki khal. Length of Barki khal is approximately 1.5 km and width about 150 ft-200 ft. Water depth of Barki khal was observed 10 -12 ft in September 2000. Water depth of the khal comes down to 4-5 ft in the dry season.

Boro Haorer gangina is connected with Bizna River by a direct channel, which flows through Barki khal and Kanlakhai khal. Kanlakhai khal is approximately 2 km long. Dinarpur and Khalilpur villages are situated on the two sides of this khal. During the study period, 10-12 ft water depth was also observed in the Kanlakhai khal and the width was found about 120 ft. Water depth at meeting point of Barki and Kanlakhai khal found 20 ft in September 2000.

From the connecting point of Kanlakhai khal, water depth varies in different places from 10 to 16 ft. From 600 ft away of the meeting point, water depth was found only 6 ft and both side of this portion is covered by water hyacinth. This portion is fully dried up in the dry season. There are 2 cross dykes on Barki and Kanlakhai khal made by adjacent landowners to block water for dry season irrigation.

Water of Naiya khal, Jogi khal, Halimpur khal and Dewannagar khal flows through Barki and Kanlakhai khal. It is to be mentioned that these four khals are connected with Morcha gaang and Morcha gang meets with this channel by Fenlai beel and Boro Haor.

Physical Features of water connectivity from Ailtajuri Khal to Boro Haor then Bizna through Katma beel, Pagla khal and Sewrakhai khal.

Ailtajuri khal is the downstream of Kamarkhali Khal, which falls in to Septi Beel located adjacent of Boro Haor. Hari khal originated from SBR joins Ailtajuri Khal before falling in to Septi Beel.

Ailtajuri khal is about 1.5 km long, 25-30 ft wide and 1 ft to 1.5 ft deep. There is private land on the east of the khal while the land on the west is *khas* (Plot No. 2512 and *Khatian* No. 01). The upstream of Ailtajuri is covered with water hyacinth and most part of it is silted up. As a result, water spills over the bank of the khal. It is also worth to mention that at some points adjacent land elevation is lower than the khal bed. During visiting time, water was observed flowing on the adjacent land surface (depth 6ft).

Water depth in Septi Beel was found 6 ft. The Septi khal, originating from Septi Beel flows through three separate beels in the Boro Haor (e.g. Katma Beel, Pagla Beel and Sewrakhai Beel) and finally falls into Bizna River through Sewrakhai khal. The width and depth of the Septi khal was found about 100 ft and 10 ft during field survey. As reported by the local people, 3-4ft water retains in the khal in the dry season.

Presently average width of this channel (Katma Beel to Bizna River) is 50 ft. During physical investigation, it has been found 10 to 12 ft depth of water in this channel. Local community mentioned that during dry season this khal retains about 5 ft of water.

Local people constructed 10-12 cross dykes at different points over the entire channel starting from Katma Beel to Sewrakhai khal for keeping water for dry season irrigation purposes. The people mentioned that dykes could be removed if dry season water flow for the irrigation purposes is ensured. Water movement along with fish migration would be higher if this channel could be re-opened through removal of dykes and re-establishing connectivity with Shakha Borak River.

Dead and closed Khals

Kiaraona Khal

Overview: A large and wide khal originating from Shakha Borak River this khal used to drain water to Morcha Gaang. Around 70 years back, people of Dinarpur, Sadarghat, Phutarchar, Kaostogram closed the khal by building the Kamarkhali embankment. Later on a paved road from Sarker Bazar to Gopla Bazar was made which closed the khal permanently. At present there is a big mosque and Madrasha at the mouth of the khal. People reported that (Upstream and downstream) it would not be possible to reopen this khal.

Phutarchar Khal

Originated from Shakha Borak and joint with Bizna River. This khal was closed about 25 years back. Stagnant water found in the khal. This khal was embanked and now a paved road closed the khal. Khal is now fully covered with water hyacinth. The people of the surrounding area are not interested to reopen the khal.

Gopi Khal: The khal is severely silted up and there exists hardly any trace of the khal. Most part of the khal is encroached and converted in to cropland. There is no possibility of doing any rehabilitation work in this khal.

Teli khal and Baitakhali Khal: These Khals are completely dead and being used as cropland. Some settlements are also found on Baitakhali khal. People of the surrounding area are not interested to reopen the khal.

Kamarkhali Khal

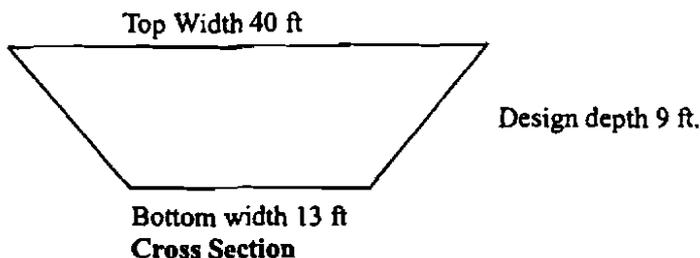
This is one of the major khal originated from Kushiya River and feed Boro Haor. This khal has different local names at different places such as Kamarkhali from its off take then Tana khali, Kaitla khal and finally called Ailtajuri before falling in to Boro Haor. The upstream the khal (off take) was closed about 40/50 years back (information obtained from local people) by embankment to protect the villages and crops of downstream in the Boro Haor area. The crop and settlements at the downstream were subject to recurrent damage by the floodwater before the closure. Therefore, the community of the affected area collectively made a strong protest to the concerned authority and demanded the closure of the channel. Considering the disastrous effect caused by the khal, BWDB eventually embanked the mouth of the khal. But the closure caused adverse impact on the livelihood of communities live in the up stream villages due to shortage of water. A number of fishermen living in the upstream villages deprived of catching fish and the farmers encounter acute shortage of water for cultivation. Observing the situation, BWDB took a decision to divert water from Shaka Borak to Kamarkhali Khal. Accordingly, a khal were excavated (Katakhal) to join the Shakha Borak with Kamarkhali Khal and set up a sluice gate in order to control water and flushing.

Following closure of the Kamarkhali Khal, the downstream farmers are benefited as the severity of flood reduced which ensured crop production. The sluice gate is controlled by a section of influential people and two operators (recruited by BWDB). There is an operational and maintenance committee consisting of 10 member's including Ex. Upazila Chairman, Ex UP Chairman and farmers from upstream and downstream villages. The committee is headed by Ex. UP Chairman (Monumukh UP) is the most influential person. He also acts as secretary of the committee.

There is another committee, which was formed with the officials of different offices. The member of the committee included Executive Engineer and Sub-divisional Engineer of BWDB, Upazila Nirbahi Officer, Upazila Agriculture Officer, District Fishery Officer and others. The committee was constituted to solve problems discussing with the local people.

Hydrological Analysis of Shakha Borak River, proposed Khals for rehabilitation and Bizna River

In order to bring water from the Shakha Borak to the Boro Haor and then to Hail Haor, the Shakha Borak River needs to be re-excavated to certain extent and a maximum net depth of 4 ft has been considered. After developing Shakha Borak River the cross section will be as following:



During study period (Mid Sep'2000) average water depth found 5 ft. So after developing maximum water depth may arise up to 8 ft.

$$Q = Av = AC \sqrt{mi}$$

Here,

Q= Quantity of water

A= Water area of the Channel

C= Chezy's constant

m= Average hydraulic mean depth

i = Bed slope.

b= Width of the bottom of channel

P= Wet perimeter

$$A = (b + nd) d = (13 + 1.5 \times 8) 8 = 200 \text{ Sqft.}$$

$$C = 55 \text{ [Chezy's constant, let 55]}$$

$$i = \text{Bed slope } 0.00033 \text{ [as per field situation } i = 1 : \frac{3000 \text{ in feet}}{\text{]}}$$

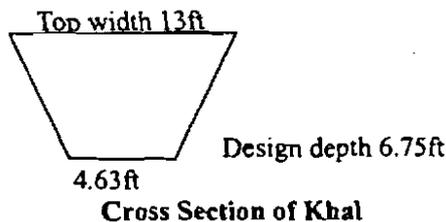
$$P = \text{Wet perimeter} = b + 2d \sqrt{\{n^2 + 1\}} = 13 + 2 \times 8 \sqrt{(1.5 \times 1.5) + 1} = 41.48 \text{ ft}$$

$$m = A/P = 200/41.84 = 4.78 \text{ ft}$$

$$\therefore Q = 200 \times 55 \sqrt{4.78 \times 0.00033} = 416.55 \text{ Cft/ Sec} = 11.79 \text{ Cum/Sec}$$

So, Per day water will enter $11.79 \times 60 \times 60 \times 24 = 1,018,656 \text{ Cum/day}$.

The potential khal's those could be re-excavated, a maximum top width of 12ft-15ft and maximum 3 ft net depth will be possible to re-excavate. Proposed cross section is as follows;



Side slope considered 1:1.5 is only in the net depth portion due to inadequate width. So regarding entire section actual slope ratio will be 1: 0.62. From the original ground level total design depth of the khal is 6.75ft. Average net depth 2.75ft considered.

During study period team found that the velocity of water in the khal is maximum 30ft/min (Sep'2000). So in the month of March-April it may increase up to 40ft/min. Average water depth found 3ft. After opening of these khals, water may pass maximum 4ft height during monsoon. As per physical condition gradient considered 1: 2000.

So on the basis of above mentioned, hydrological features the analysis are following.

We know that,

$$Q = Av = AC \sqrt{mi}$$

Here,

Q= Quantity of water

A= Water area of the Channel

C= Chezy's constant

m= Average hydraulic mean depth

i =Bed slope.

b= Width of the bottom of channel

P= Wet perimeter

$$A = (b+nd)d = (4.63 + 1.5 \times 4) \times 4 = 42.52 \text{ Sqft.}$$

$$\begin{aligned} \text{Wet perimeter } P &= b + 2d \sqrt{\{n^2 + 1\}} \\ &= 4.63 + 2 \times 4 \sqrt{\{(1.5 \times 1.5) + 1\}} \\ &= 19.05 \text{ft} \end{aligned}$$

Average hydraulic mean depth [Let Chezy's constant 55.]

$$m = A/P = 42.52/19.05 = 2.23 \text{ft}$$

$$Q = AC\sqrt{mi} = 42.52 \times 55 \sqrt{2.23 \times .0005} = 78.08 \text{ Cft/Sec}$$

So, by 5 khal total $78.08 \times 5 = 390 \text{ Cft/Sec}$ i.e. 11.05 Cum/ Sec water will enter in Boro haor.

Therefore, per day $11.05 \times 60 \times 60 \times 24 = 954,720 \text{ Cum/day}$.

Area of Boro Haor is 4,520 ha. (as per report of BWDB) i.e. 45,200,000 Sqm.

∴ Water will rise in Boro Haor (if no discharge) 0.022 meter ~ 1inch.

1,018,656 Cum/day volume of water which will enter in Shakha Borak, by 5 khals total 954,720 Cum/day volume of water will pass in Boro Haor and rest 63,936 cum water will run towards Mora gang then Meghna.

The channel that is connected between Boro Haor to Bizna is 6ft down from the Boro Haor bed level. Total length of the channel is 9000m, average width is 23m and depth is 1.8m. So this channel can hold 372,600 Cum of water and later the water level seems to be at same level of Boro Haor. So the additional water will affect on Boro Haor by 1/2 inch per day if there is no discharge through Bizna.

Presently Bizna River discharging 22,548,065 cum/day (measured on Mid September 2000 by taking velocity of water and cross section of the river). So after implementation of proposed intervention (re-excavation of mentioned khals), an additional water volume of 954,720 cum/day will enter in to Bizna River, which is 1/23th of existing capacity of Bizna. As per water level data this water will be discharged (Figure 1).

As per physical condition in between Boro Haor and Bizna there are no dike/ embankment or sluice gates. Presently it is fully open and Boro Haor water discharges through Bizna. So water level elevation is same. Bed elevation could be different, water depth could be different but water level elevation should be same.

Detail RRA findings**1. RRA findings matrix of the Boro Haor vicinity villages:**

Topics/Issues	Sadarghat	Satak	Baithakhali
Village profile/ population	1200 HHs. About 50% farmer, 5% fisherman, 5% Service holder, 35% daily labor and 5% Businessmen	400 HHs. About 80% farmer, 5% Service holder, 10% daily labour and 5% businessmen	60 HHs in Bathakhali. About 90% farmer and 10% others. 200 HHs in Hazipur, about 70% farmer, 15% service holder and 15% others.
Soil/land condition and drainage/ water logging	Silt clay soil, lands are medium low. The farmers retain water through dikes in the canal to irrigate Boro rice. Receding water requires a month. No water logging was reported.	Silt clay soil, lands are medium low. The farmers retain water through dikes in the canal to irrigate Boro rice. Receding water requires a month. No water logging was reported.	Silt clay soil, lands are medium high. The farmers retain water through dikes in the canal to irrigate Boro rice. Receding water requires a month. No water logging was reported.
Crop & cropping pattern	Boro (local and HYV) and Amon rice cultivated. Seedbed prepared in November (Kartik) and transplanted in December (Poush). Boro rice harvested in April- May (Baishak) and Amon in November-December (Agrahaon). Local Boro is about 90% Boro HYV only 10% (irrigated). Local Boro can be harvested early by April (Baishak). Production of local Boro is about 25 mond/Acre, where as 45 mond/Acre of Boro HYV. Cost is also higher.		
Crop damage	The Boro crops are vulnerable to inundation by early flood in April-May (Baishaak). During last five years they lost Boro rice twice (70% land inundated).	The Boro crops are vulnerable to inundation by early flood in April- May (Baishaak). During last five years they lost Boro rice twice (90% Boro were damaged).	The Boro crops are vulnerable to inundation by early flood in April-May (Baishaak). During last five years they lost Boro rice twice (10% Boro were damaged).
Fisheries situation	Less fish available in the area after construction of sluice gate. Stoking/fish culture is almost absent.		
Other aquatic resources situation	Abundance of Aquatic vegetation including fodder were more before the closure compared to present situation		
Wild life situation	Water fowl/migratory birds and other wild lives were abundant. At present only few fox and some time chita bagh are seen occasionally.		
Comment on reestablishing connectivity	Connectivity could be reestablished keeping provision for water control through sluice gate in the Shakha Borak and desilt the Bizna.		

2. Matrix showing RRA finding of the up stream villages by Khals

Topics/Issues	Halimpur Khal	Jogi Khal	Naiya Khal
Villages studied:	Gorarai, Katarai & Halimpur	Gorarai, Katarai & Halimpur	Chandpur & Khanjanpur
Village profile /population	Gorarai: 80 HHs, about 50% farmer, 25% daily labour, 20% service holder and 5% businessmen. Halimpur: 100 HHs, about 60% farmer, 30% daily labour, 5% service holder and 5% businessmen. Katarai: About 125 HHs, about 60% farmer, 20% daily labour, 15% service holder and 5% businessmen. No professional fishermen in these three villages.		Chanpur: 125 HHs, about 70% fishermen, 20% farmer, 10% daily labour, 5% service holder and 5% businessmen. Khanjanpur: 125 HHs, about 70% fishermen, 20% farmer, 10% daily labour, 5% service holder and 5% businessmen.
Stream physical profile	Silt clay soil, average 5 ft deep, 10 ft. width There is a box culvert (running) on the khal, not leased out.	Silt clay soil, average 3-4 ft deep, 8-20 ft. width, 3 running box culvert on the canal, not leased out.	Soil type of this khal is clay. The khal is not leased out. During wet season on an average of 4.5 ft water depth and 11 ft width (Sept '00). There is a box culvert (running) on the khal.
Previous hydrological information	During the past considerable water was flowing through the canal and people used the water for various purposes like fishing, navigation, transportation etc.		
Present hydrological information	There is no flow during dry season. Stagnant water remains in some portion of the canal <i>In wet season a minimum flow of 25-30 ft./minute (Sep '00) in both the streams.</i>	There is no flow during dry season. Stagnant water remains in some portion of the canal.	
Crop & cropping pattern in the associated lands	Only Amon crop is there, other crop can not be cultivated due to shortage of water.		
Comment on reestablishing connectivity	Participants showed their keen interest for reopening of the Khal and desilt the relevant portion of Shakha Borak and its joining khals.		

2. Matrix showing RRA finding of the up stream villages by Khals (Continued)

Topics/Issues	Hari Khal	Dewan Nagar Khal	Shakha Borak	Kamarkhali
Village profile /population	East Lamua: About 150 HHs, 20% fishermen, 60% farmer, 10% daily labor, 5% service holder and 5% businessmen. Khanjanpur: About 115 HHs, 15% fishermen, 65% farmer, 10% daily labor, 5% service holder	About 150 HHs, 20% fishermen, 60% farmer, 10% daily labor, 5% service holder and 5% businessmen.	Fatehpur + Nasirpur (Same MOUza): About 800 HHs 60% farmer, 3% fishermen, 3% daily labor, % service holder and business 25%. Mukimpur: About 50 HHs, 45%farmer, 45% fishermen, 10% other's Alapur: About 250 HHs,t 75% farmer,	In Ghorakhal and Baorbhag (Same Mouza) village total nos. of houses are about 3000. About 60%farmer, 5% fisherman, 10% daily labour, 15% service holder and business 20%. In Karimpur village total nos. of houses are about 1200. About 75%farmer, 15% Service holder and 10% other's

Topics/Issues	Hari Khal	Dewan Nagar Khal	Shakha Borak	Kamarkhali
	and 5% businessmen.		15% Service holder and 10% other's	
Stream physical Profile	Silt clay soil, box culvert on off take, not leased out. 6- 7 ft. deep, 15 ft wide. Mouth closed by villagers	Clay soil, box culvert, no lease, 4 ft deep, 7/8 ft. wide	Clay soil, no lease, 8-12 ft deep, 70-80 ft. wide.	Silt clay soil. average 11-13 ft water depth and 70-80 ft width.
Present hydrological information	No flow, stagnant water, capacity reduced.	No flow, stagnant water	Dry season no flow. In wet season 60 – 120 m/min at different point (September 00)	Closed mouth, recieve water from Shakha Borak through Katakhal when the sluice is open.
Previous hydrological information	Following less flow of the Borak adjoining Hari khal got silted up resulting reduced capacity. While water enter from the Borak, water over spills that is why local community embanked the off take of the khal	Was a flowing khal.	It was a vigorous river before closure of the Phuter chhar,,Kironar Khal and reexcavation of katakhal and diverting water to the Kamarkhali.	It was a vigorous River.
Crop & cropping pattern in the associated lands	Only Amon rice, other crop can not be cultivated due to shortage of water. Previously the area had more water and sedimentation produced more crops.			
Comment on reestablishing connectivity	People are willing to take part in the process of planning, designing, implementing and managing the khal. They believe opening of the khal shall bring back their future in farming and increased water flow shall provide them better life like old days.			

List of Participants of RRA Sessions at Different Locations

Sadarghat, Venue: Sadarghat Natun Bazar Farque Mia's house	
Hadi Gazi	Ex. Upazila Chairman
Abdul Gafur	Farmer
Rahmat Ali	Farmer
Abdul Ahad	Farmer
Monzur Khan	Farmer
Shah Ali Newaz	Farmer
Jalal Uddin	Farmer
Alamullah	Farmer
Shah Asik Ali	Farmer
Shah Minot Ali	Farmer
Shah Afzal Mia	Farmer
Shah Abdur Rashid	Trading
Md. Asad Mia	Farmer (UP Member)
Mostafa Chowdhury	Farmer
Sabaj Mia	Farmer
Ali Mia	Farmer
Arabullah	Farmer
Hazi Abdul Kader	Farmer
Khorajullah	Farmer
Hossainullah	Farmer
Haider Ali	Farmer
Samsar Ali	Farmer
Sitar Ali	Trading
Khoir Ali	Service
Satak, Venue: Lugao Primary School	
Abdus Sobahan	Service (Post master)
M.A. Hamid Gouri	Service (Head Teacher)
Rahimullah	Farmer
Abdul Mottalib	Farmer
Isahakullah	Farmer
Alauddin	Day laborer
Delower Mia	Farmer
Nuruzzaman	Farmer
Abdul Latif	Farmer
Ala Mia	Trading
Daradarpur, Venue: Moulana Lokman mia's house Hazipur Baz	
Moulana Lokman Mia	Farmer
Shajidullah	Farmer
Salu Mia	Farmer
Almun Mia	Farmer
Amzadullah	Farmer
Iskandar Ali	Farmer
Samirullah	Farmer
Sikandar Ali	Farmer
Jomsed Ali	Farmer

Monjur Mia	Day laborer
Hazipur, Venue: Moulana Lokman mia's house Hazipur Baz	
Md. Lutfar Rahman	Farmer
Abdul Gafur	Farmer
Harun Mia	Farmer
Faruque Mia	Farmer
Iza Mia	Farmer
Abdur Rahim	Farmer
Sonabar Mia	Farmer
Asadur Mia	Service
Abrus Mia	Trading
Lal Mia	Doctor
Halimpur, Venue: Gorarai (Misilganj)	
Abdul Jalil	Teacher
Alhaz Abdur Rashid	Farmer
Alhaz Abdul hamid	Farmer
Saiyad Mabud Ali	Doctor
Badsha Mia	Farmer
Abul Asad	Farmer
Katarai, Venue: Gorarai (Misilganj)	
Md. Khalilur Rahman	UP Member
Md. Mashuk Mia	Farmer, Ex UP Member
Md. Abdur Rahim	Farmer
Md. Abdul hossain	Farmer
Md. Abdul Hye	Farmer
Faruqe Mia	Farmer
Abdul Hauque	Farmer
Alhaz Abdul Bari	Farmer
Abdul Matin	Farmer
Alhaz Abdur Rahman	Trading
Gorarai, Venue: Gorarai (Misilganj)	
Alhaz Matin Chowdhury	Farmer
Shah Mahmud Ali	Farmer
Alhaz Surot Mia	Farmer
Alhaz Dhonu Mia	Farmer
Alhaz Abu Mia	Trading
Chanpur, Venue: Shafiullah's house adjacent of Naiya Khal	
Md. Shafiullah	Trading
Islamullah	Trading
Barkat Ali	Imam
Akkel Mia	Fisherman
Rajab Ali	Fisherman
Hazi Sameer uddin	Farmer
Khanjampur, Venue: Shafiullah's house adjacent of Naiya Khal	
Sajedullah	Fisherman
Edon Ali	Fisherman
Aslam ullah	Farmer
Abdul Jalil	Farmer

Abdul Jabbar	Farmer
Borhan uddin	Ex. UP Chairman
Nuruddin	Service holder
Zahid Ali	Farmer
Forkan ullah	Daily laborer
E. Lamua/W. Saduhat! Venue: On the Embankment of Kiraona Khal	
Sajan Mia	Farmer
Nagendra Nath	Fisherman
Karamatullah	Trading
Abdul Hannan	Service
Ekhlasur Rahman	Farmer
Md. Abdul Barik	Service
Abdus Salam	Farmer
Surak Mia	Farmer
Firoz Mia	Farmer
Abdus Salam	Farmer
Bali Mia	Farmer
Fatehpur, Venue: Fatehpur Eidgah adjoining place	
Md. Sahajan Mia	Ex. UP member
Abdur Razzak Mia	Farmer
Musahid Mia	Trading
Sohel	Trading
Mohsin	Student
Abdul Mia	Trading
Abdul Matin Mia	Farmer
Motabber Mia	Farmer
Hazi Chikon Mia	Farmer
Md. Munshi Mia	Farmer
Hazi Moina Mia	Farmer
Hazi Hasan Mia	Farmer
Md. Monor Mia	Farmer
Md. Afroz Mia	Farmer
Sree Akhol Akanda	Fisherman
Sree Premananda	Fisherman
Sree Ramtai nanda	Fisherman
Hazi Abul Aise	Teacher
Tiroza Mia	Teacher
Moulana Goffer Mia	Teacher
Mukimpur, Venue: Mukimpur Madrasha	
Hazi Mohabbat Khan	Farmer
Babul Khan	Farmer
Aslam Khan	Farmer
Sree Imangsh Das	Day laborer
Soleman Khan	Farmer
Konor khan	Farmer
Anower khan	Farmer
Abdul Jalil	Farmer
Abu Soma	Fisherman

Nannu Mia	Fisherman
Abdul Haque	Business
Abdul Ukil	Principal of Madrasha
Sundar khan	Farmer
Morshed Mia	Farmer
Alapur, Venue: House of Abdus Sattar at Alapur	
Abdus Sattar	Farmer
Anowar Mia	Farmer
Moshahid Mia	Business
Abdur Mia	Business
Alaur Mia	Service
Alal Mia	Farmer
Hazi Afroz	Retd. Teacher
Abdur Rahman	Farmer
Wakir Mia	Farmer
Bashir mia	Service
Abdullah	Farmer
Abdul kalam	Farmer
Raja Mia	Business
Ghorakhal Venue: Kamarkhali Bridge (House of Warishullah)	
Md. Arosh Ali	Farmer
Mohon	Farmer
Faizul Haque	Farmer
Jorif Mia	Farmer
Abdur Rahim	Business
Baorbhag, Venue: Kamarkhali Bridge (House of Warishullah)	
Abdur Rouf	Farmer
Nazrul Islam	Student
Yattar Mia	Farmer
Abdul Hadi	Farmer
Kois Uddin	Farmer
Karimpur, Venue: Kamarkhali Bridge (House of Warishullah)	
Md. Rabbani Mia	Farmer (Ex. Up member)
Faizur Rahman	Farmer
Sujan Mia	Farmer
Khalish	Farmer
Rahmatullah	Farmer
Mahmud Mia	Farmer
Monormon Sarkar	Fisherman
Dayamoy Sarkar	Fisherman
Raise Mia	Farmer
Abdul Bari	Farmer
Abdur Rouf	Farmer
Warishullah	Farmer
Debarpukur, Venue: House of Hazi Karque Mia	
Mahtab Ali	Farmer
Salik	Fisherman
Mono Mia	Carpenter

Sree Sunil	Doctor
Getendra Gosh	Fisherman
Badsha Mia	Fisherman
Hazi Farque	Fisherman
Faruque Mia	Fisherman
Nazir Mia	Fisherman
Shahid Ali	Fisherman

Participants of Stakeholders meetings at different locations

Bahadurpur, Venue: House of Kamaruddin (Ex. UP Chairman)	
Md. Kamaruddin	Ex. UP member
Abdur Razzak	Farmer
Sree Anil Chandra Sarker	Village doctor
Fazlur Rahman	Fisherman
Mohammadullah	Fisherman
Asadullah	Fisherman
Moklesullah	Farmer
Ashraf Ali	Fisherman
Sajibullah	Fisherman
Ashraf uddin	Fisherman
Kalaiullah	Fisherman
Addus Sattar	Fisherman
Mokterullah	Fisherman
Kaostogram, Venue: Kaostogram Bazar	
Ekhlas uddin	Farmer
Khandakar Abul	Farmer
Jahir ullah	Farmer
Mukid Mia	Farmer
Mokles Mia	Fisherman
Habibur Rahman	Fisherman
Dinesh Chandra	Fisherman
Khirod	Fisherman
Bahadur Ali	Fisherman
Hannan	Fisherman
Abul Ali	Fisherman
Hanif	Fisherman
Sadarghat, Venue: Sadarghat Bazar	
Hadi Gazi	Ex. Upazila Chairman
Abdul Gafur	Farmer
Rahmat Ali	Farmer
Abdul Ahad	Farmer
Monzur Khan	Farmer
Shah Ali Newaz	Farmer
Jalal Uddin	Farmer

Alamullah	Farmer
Shah Asik Ali	Farmer
Shah Minot Ali	Farmer
Shah Afzal Mia	Farmer
Shah Abdur Rashid	Trading
Phutarchar, Venue: Bazar	
Moktar Mia	Farmer
Surat Mia	Farmer
Alfaz Mia	Farmer
Zahir Mia	Farmer
Wadud Mia	Farmer
Yunus Mia	Trading
Sahid Mia	Farmer
Jhitka, Venue: Phutarchar embankment adjoining place	
Siraj Mia	Farmer
Ala Mia	Farmer
Nurul Amin	Farmer
Monai Mia	Farmer
Atakur Mia	Service
Azizur Mia	Trading
Mozid khan	Farmer

Estimated volume of earth to desilted from proposed khals/rivers

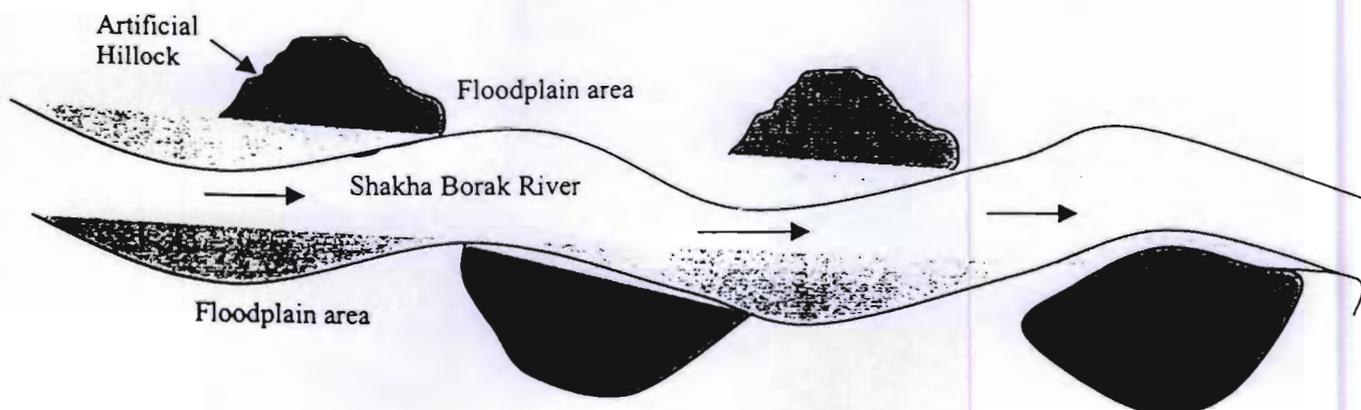
Following are the necessary earthwork required to reestablish the connectivity between Kushiyara River and Hail Haor. Estimated earthwork volume is as follows:

Name	Top Length (m)	Top Width (m)	Av. Width (m)	Design depth (m)	Net depth (m)	Slope	N/E Volume (cum)
A	B	c	d	e	f	g	H= b x d x f
Shakha Borak River	14500	12.2	8.11	2.73	1.21	1: 1.5	142,290
Hari Khal	3000	4.6	3.24	2.13	0.91	-	8,846
Naiya Khal	1890	4.5	3.14	1.82	0.91	-	5,400
Jogi Khal	1920	4.5	3.36	2.13	0.76	-	4,902
Halimpur Khal	1940	3.65	2.29	2.28	0.91	-	4,042
Dewannagar Khal	1500	2.43	1.29	1.98	0.76	-	1,470
Morcha Gang	4000	18.29	13.73	3.04	0.76	1:1.5	41,739
Ailtajuri	1500	9.15	6.96	1.46	1.00	1:1.5	10,440
Kanlakhai Khal	185	18.00	13.44	3.04	1.22	1:1.5	3,033
Katma beel, Pagla beel and Sewrakhai khal in this channel for removing cross dyke total N/E will be required							500
In Kanlakhai channel for removing 12 nos. cross dyke N/E will be required							1,000
Grand Total N/E volume for re-excavation							223,662

** N/ E means Net earthwork.

** In case of connecting khal, actual slope not considered due to inadequate width. Here slope has been considered based on net excavation portion (not on total design depth) and on that basis volume calculation has been done.

Excavated Earth dumping: In order to dump the re-excavated earth, there could be various options i.e. the earth could be removed all together from the area, which is not economically feasible. On the other hand, dyke along the riverside what is usually done in the engineering project could not be considered in an environmental project. MACH therefore, decided to make mini forest (swamp) on the dumped soil along the side stream. The dumping would be made in the form of artificial hillocks. So that the floodplain remains open, at the same time earth could be dumped and plantation cover would create and enhance habitats. Model of proposed hillocks are shown below:



Total Net earthwork will come from this channel is 142,290 cum.

Total length of this channel is 14500meter.

There are two options for making dyke and that's different in size of area

- i) Size of hillock will be: Base 100m x 10m x 3.04m in this size total hillock will be required 90 nos.
- ii) Size of hillock will be: Base 61m x 21.34m x 3.04 in this size total hillock will be required 50 nos.
- iii) Size of hillock will be: Base 100m x 15m x 3.04 in this size total hillock will be required 65 nos.

On the connecting khals there is requirement of ring culvert for easy movement from one side to another. Total 4 culverts will be required. Positions of culverts are Hari khal (2 nos.) Naiya khal (1 no) and Halimpur khal (1no).