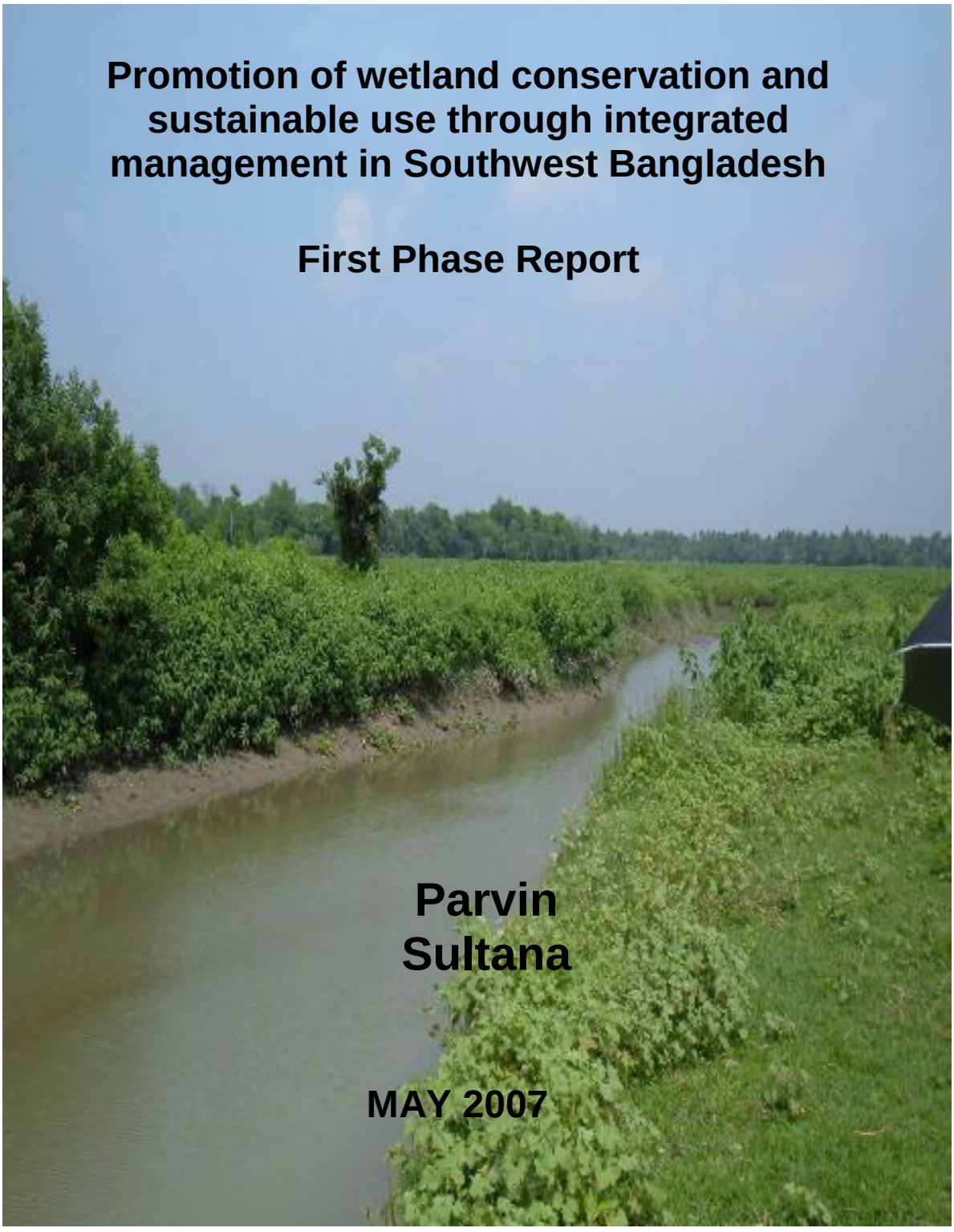
Promotion of wetland conservation and sustainable use through integrated management in Southwest Bangladesh

First Phase Report



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EXECUTIVE SUMMARY

Korgar Beel is a 222 hectare seasonally flooded depression in southwest Bangladesh located in Narail Sadar Upazila, Narail District. Although the area is inundated for half of the year, it holds little water in the dry season. The natural resources of the area have degraded and been over-exploited over the years. Most land is now cultivated with high yielding varieties of rice in the dry season which require irrigation and high inputs. Aquatic plants and fish diversity and catches were reported to have declined.

There are 220 households living in three villages around the beel. A survey of 89 households found that the majority are Hindu, education levels are low, 57% of households live in small single room tin-roofed houses, and 37% are effectively landless, while only 19% own more than 1 hectare of land. Over half of the households report that they have insufficient food for at least part of the year. Up to two-thirds of the households catch fish, although only a quarter earn any income from this. In addition between 10% and 40% are involved in using other natural resources (plants, snails and crabs) from the beel.

Most fishing is done with individually operated gears such as traps, gill nets and hook and line. Traditional fish aggregating devices and team harvesting of these are also important. Only 14 fish species were recorded in a detailed monitoring programme and were dominated by small fishes and snakeheads. The fishery is depleted and has a low productivity at about 20 kg/ha. While it generates a useful income and source of food for local people it has considerable scope to be restored. Agriculture is dominated by high yielding varieties of irrigated dry season rice, offering scope for crop diversification. We hope to monitor in more detail use of other aquatic resources and identify ways of enhancing these in future.

In interviews and a Participatory Action Plan Development workshop with all stakeholders, there was common agreement that fish were declining in the beel and that there were water management related problems notably entry of water hyacinth into the beel from the river, floods during the monsoon (wet season) and lack of surface water in the dry season. To raise awareness on issues related to integrated management of floodplain resources and their conservation a drama was developed

and performed on site by a local theatre group. Two visits by Korgar Beel stakeholders were made to other floodplains where communities have already taken initiatives such as fish sanctuaries to conserve and restore resources.

The community reached agreement on a set of management activities aimed at improving management of the beel for the benefit of both aquatic resources and farming. They formed a 15-member Beel Management Committee, and the project team has arranged some training for them. This committee has raised funds from among the community to make a temporary sluice to control water flow in the canal connecting the beel with the river, and to release fish fingerlings into the beel. They have declared the canal a fish sanctuary, and aim in 2007 to increase the population of native fishes in the beel.

The community concluded at the end of the year that they had gained in terms of coordinated management of resources, better communication with government agencies, enhanced knowledge and motivation, and had initiated a closed fishing season, fish sanctuary, and water management. How effective this is will only be seen from 2007 onwards. Future activities proposed include demonstrations of less water-hungry crops, re-introduction of lost fish species, tree planting and habitat restoration, and fine tuning water management. The community will need support to ensure that the poor benefit from this, in accessing advice and appropriate species for release, and in monitoring and assessing impacts.

CHAPTER 1:
BACKGROUND AND CONTEXT

Fishing in canal, Korgar Beel

"Korgar Beel" is named after one of the largest villages within the beel area, and is located in Narail Sadar Upazila, Narail District, southwest Bangladesh. It was selected for "Promotion of wetland conservation and sustainable use through integrated management" project activities. This beel or floodplain depression is seasonally flooded, but keeps water throughout the year in small deeper pockets and canals. It was selected because it is a degraded wetland typical of this region. The additional reason for its selection was that the area comprises seasonal floodplains under private ownership. Participatory Action Plan Development (see Chapter 3) in the year 2000 in a similar nearby beel (Kathuria Beel) had indicated interest among people there in a range of floodplain management measures and the team assessed that there was scope to adapt recommendations from such areas to Korgar Beel.

Located in Korgram and Bahirgram Mouzas, Mulia Union, Narail Sadar Upazila, Narail District, this beel is officially known as Hunner Beel but to the villagers it is Korgar Beel or Korgram Beel. Officially the beel area is 550 acres (222 ha). Korgar Beel was a natural harbour of different natural resources in the past. In the dry season farmers cultivated rice and other *rabi* (dry season) crops. During the monsoon and early monsoon period farmers were cultivating two mixed rice crops -

broadcast Aus and Aman[1]. Aquatic resources were abundant in quantity and variety (fish, snails, plants, etc.). Unlike many other natural resource bases, negative ecological changes in this lotic aquatic system occurred in the last few decades due to past and ongoing development activities. Ecological changes due to environmental and anthropogenic factors are major threats to the survival of the local people. Changes in river channels, reduced dry season flows from upstream areas and intrusion of saline water in the dry season have been causing constant and cumulative deterioration of the existing environmental and adversely affect inhabitant's livelihoods.

Topographically most of the area is an aquatic environment. Besides homestead lands around the beel which are raised above flood levels, only 11% of the land is considered to be high where during the dry season people can cultivate rabi crops such as grass peas etc. About 50% of land is considered to be medium-high and remains under water for 6 months in a year, and the rest of the land remains under water throughout the year.

During the early 20th century this beel was full of *nol khagra* (native aquatic grasses, *Saccharum spontaneum* and related species*).* These grasses were cleared by local farmers who made the land suitable for cultivation. During that period farmer's cultivated local varieties of deep water rice in the deeper areas of the beel and rabi crops in the higher ground. There was also a diversity of native fishes in the beel. After the building of Farrakka Barrage on the Ganges in India, which started operating in the 1970s, the dry season water flow decreased and in some lands farmers started to cultivate early monsoon rice and other crops. During the 1980s farmers started to grow HYV rice which needs lots of fertilizer and pesticide with irrigation in the dry season. Moreover, backflow of saline water at the harvesting period made crop cultivation a problem. During successive monsoons river bank erosion and high flow of water have created smaller canals inside the beel. This situation is suitable for restoration of fish during monsoon. The local people think that fish and other aquatic resources are god-gifted resources and they harvest them without considering the future. They had no idea that conservation measures for these aquatic resources might ensure greater productivity.

[1] Aus are early monsoon rice varieties that are less flood tolerant, Aman are late monsoon rive varieties and in this case were "deepwater" varieties that can elongate with rising flood waters. The two types of rice were broadcast together before the monsoon but had low yields.

The activities of this project with support of Rufford Small Grant started in May 2006. The aim was to pilot the Integrated Floodplain Management (IFM) approach in this area with the aim of establishing sustainable floodplain use and wetland / fishery conservation in this degraded wetland. There was initial mistrust of outsiders in the local community as some outside people had recently leased the adjacent *beel* (wetland), used this land to borrow money and then flew away with the money, leaving the landowners to repay the bank. With the help of local people who know of our research activities in adjacent areas, we convinced the community of our good intentions. Under this project one student of Independent University of Bangladesh was supported to carryout field research on "History and local knowledge of floodplain resources & their management in Korgar Beel in Narail District". This student project paper forms annex to this report.

Integrated Floodplain Management aims to minimize conflicts of interest and build on scope for all local people to benefit by maximizing their returns from dry season water, adopting integrated pest management, and limiting fishing to sustainable levels. This approach also aims to restore fisheries and aquatic life because it is in the interests of the local community. This is expected to be sustained by building social capital in the community through participatory planning, capacity and awareness building, networking and experience sharing with similar communities that already have adopted elements of the approach. Individuals and nature can profit when coordinated actions are taken by the community to adopt alternative crops and fish sanctuaries.

CHAPTER 2:
STUDY METHODOLOGY

2.1 Integrated Floodplain Management Approach

The first main element of the project was to establish a body for community based beel management which was done after a series of meeting with the community, local elites and the local fisheries and agriculture extension officers. The second element was community participation in planning. For this the project team drew upon a participatory method named Participatory Action Plan Development (PAPD). The third element, the options that could improve floodplain management involved setting rules, alternate crop introduction, and management capacity building. In addition, knowledge sharing through exposure visits and different surveys were done.

The concept of Integrated Floodplain Management is that through this process opportunities can be found for restoring and enhancing the productivity of floodplains that take account of the ecosystem as a whole and how agriculture, water management and aquatic resources (fish and others) are interconnected.

2.2 Action research

As an action research project, monitoring and participatory assessment activities were an integral part of the project field activities, they are summarised in Table 2.1. The methods involved are explained in more detail in the following sections.

Table 2.1 Summary of data collected from project site

Type of data collected	Status
Quantitative	
Census	A complete census of the households within the beel catchment area (220). Some questions were asked during census on needs and constraints also
Household baseline survey	sample survey of 90 households covering assets, income, fishing and other activities and opinion about fishery and biodiversity.

Type of data collected	Status
Household (farm) survey, covering by plot land characteristics, crops grown, inputs and outputs	detailed survey of 90 farmers around the canal
Fishing effort	Monthly monitoring from June 2006 to January 2007 (as much of the area dries up there is virtually no fishing in the rest of the year)
Fish catches	Monthly monitoring from June 2006 to January 2007
Qualitative	
Workshops/feedback/PAPD with stakeholders	Planning workshop
Field staff diaries of events and changes	General diary kept since June 2006
Exposure visit	15 committee members, 20 farmers, and 2 officers from concerned departments in the upazila made a visit to observe and to know from a successful community about alternative rabi crops and fishery management

A census of all households in the area was conducted as part of the RSG supported project in early June 2006 and resulted in a sample frame that distinguished households by their poverty level and involvement in fishing.

The baseline survey design covered 90 households: 30 from professional fishers, 30 from farmer households, and 30 landless poor. Women members of the same households were interviewed with a separate supplementary questionnaire.

CHAPTER 3:
PARTICIPATORY ACTION PLAN DEVELOPMENT (PAPD)

PAPD workshop session, Korgar Beel

3.1 Introduction

The PAPD methodology developed in Bangladesh for consensus building involves holding a series of linked local workshops where different stakeholders in a wetland or fishery participate separately and then together in plenary. Through this the stakeholders are expected to identify from among their problems and possible solutions ones that are common to different stakeholders and can be agreed to be win-win options[2], taking into account the interests of different stakeholders. Through this they form a management plan for the common aquatic resources they use which is expected to improve the condition of the resource base and lives of users (Barr and Dixon, 2001). Many methods such as Participatory Rural Appraisal (PRA) aim to raise individual awareness of resource management problems; PAPD raises collective awareness of the problems and is a process leading towards collective action that can tackle them effectively.

[2] Actions that are agreed by all stakeholders to be beneficial to the community and do not make anyone worse off. However, this may not arise in locations which are strongly factionalised for other reasons, and even when there are is a consensus there may be a need for negotiation and compromises over the implementation of the plan where some people would lose in the short term (Sultana and Thompson 2004).

PAPD was originally conceived as a two-stage process comprising a problem census (listing and ranking of problems by different stakeholder groups) followed by stakeholder and plenary planning workshops. However, through application PAPD is now part of a three phase process that leads to long-term participatory resource management. Overall thirteen different stages in the process have been identified (Sultana and Thompson 2004). The first eight steps are detailed below:

I. Scoping phase (*Stages one to three)*
   1. Situational analysis (summarizing local knowledge)
   2. Stakeholder identification and analysis (through key informants)
   3. Household census and invitations to a random sample of households to PAPD (stratified by stakeholder categories)

II. Participatory planning phase - PAPD (*Stages four to eight)*
   4. Problem census (with each individual stakeholder group)
   5. Compilation of problem rankings by facilitators (combining stakeholder group rankings)
   6. Plenary with stakeholders and local leaders (to review and agree on main problems for solution analysis)
   7. Solution and impact analysis (with each individual stakeholder group)
   8. Plenary with stakeholders and secondary stakeholders (to present the process, identify feasible solutions, discuss institutional arrangements and next steps)

The steps after the PAPD proper relate to institution building and implementation of plans. In addition to the primary stakeholders as detailed in Section 3.2, representatives from different government departments participated in the PAPD process plenary sessions. Among those were Department of Fisheries, Department of Agriculture Extension, Bangladesh Water Development Board, Local Government Engineering Department, Jute Department, local Union Parishad (elected council) and one local NGO.

A feature that binds the main elements of IFM is that all members of the community-based process of PAPD should relate to the decisions and technical and social actions that are agreed to for improving IFM. An example of this could be that an individual in a particular community, whose main livelihood activity is fishing, has an understanding of the rationale behind promotion of alternative crops to *boro* (dry

season) rice with farmers of the same community. PAPD should enable such a person (commonly amongst the poorest of the community) to appreciate that less demand for water for agriculture (land side) can favour the water and associated fish production side of the floodplain ecosystem. The reverse also applies. While the main driver for a farmer's crop change may be that a new alternative crop is more profitable, the dialogue of PAPD should enable that farmer to develop an understanding of the benefits to the water resources and aquatic production of the floodplain system that can arise from a change in cropping pattern.

3.2 Outcomes of PAPD in Korgar Beel

Table 3.1 summarises the analysis of the highest priority problems identified by the four stakeholder groups in the PAPD held in July 2006.

Table 3.1 Analysis of the highest priority problems

	Problems	**Effect**	**Solution**	**Rank**
Stakeholder Group: Women				
1	Excessive water-hyacinth in the beel	Water hyacinth takes space from other aquatic plants and animals resulting in disappearance of plants (used as vegetables) and aquatic animals (duck feed)	Water regulatory structure for controlling water hyacinth	1
2	Fish declining	Very low fish population, negative impact on poor fishers	Awareness raising and training on fish conservation devices, community involvement, ban fish catch during breeding period	2
3	No monsoon crop cultivation and limited dry season crops	Inundation during monsoon and lack of water for irrigation during dry season results in cultivation of only one high risk crop	Water control structure for conserving water for fishes and crops, training on alternate crops and supply of good quality	3

	Problems	Effect	Solution	Rank
			seeds, adaptive research	
4	High demand of dowry by bridegroom's side	Poor parents have to sell their limited assets and/or take credit on high interest rate, high rate of divorce/abandoned women in the area	Social reform, awareness, implementation of government policy against dowry	4
5	Snails and aquatic plants declining	Limited/no snails or aquatic plants to collect	Build fish sanctuaries, community plan for conservation	5
6	High current in monsoon prevents conservation of fishes	Very low fish population	Build fish sanctuaries	6
7	Excessive growth of algae on the ground after flood water recedes due to long term inundation	Crop cultivation becomes difficult	Water regulatory structure	7
8	High current erodes soil in the internal canal	Loss of agricultural land	Building embankment by the side of the canal, grow trees and green fences	8
9	Entrance of saline water during late dry season	Destroys standing crop at the mature stage	Water regulatory structure for controlling saline water entrance in the beel during monsoon	9
10	Lodging of paddy during high tide	Loss of crop	Introduction of new short duration paddy	10
11	Problem in transporting crop from the field in monsoon	Loss of crop	Planting early variety	11
12	Fishes escape through the open canal to the river during low tide	Low fish diversity	Build fish sanctuaries	12
13	Use of different	Very low fish population	Impose fisheries law, local	13

	Problems	Effect	Solution	Rank
	harmful gears to catch fish	and diversity	regulation through community organisation	
Stakeholder Group: Fishers				
1	Lack of knowledge and initiatives for conservation measures	Fish declining, loss of livelihoods	Awareness raising, training on conservation of fish and other aquatic resources, adapt conservation measures	1
2	Catching fish during breeding season	Very low fish population, low income	Imposing local rules including temporary ban period	2
3	Use of different harmful gears to catch fish	Very low fish population and diversity	Imposing local rules including government policy on use of monofilament and small mesh nets	3
4	Other aquatic resources declining	Loss of livelihoods	Imposing local rules including temporary ban period during snail breeding period	4
5	Siltation of beel	Less water for fish	Re-excavation of beel, water storage for dry season	5
6	Fish escape through the open canal to the river during low tide	Low fish diversity, less income	Water resources management, conservation of fish in deep pools	6
7	Saline water enters the beel during fish breeding season destroying fish eggs	Fish declining, loss of livelihoods	Water resources management	7
8	High current in monsoon prevents conservation of fishes	Very low fish population, low income	Water resources management, conservation of fish in deep pools	8

	Problems	Effect	Solution	Rank
9	Jute retting in the beel water	Water pollution, fish disease and high fish mortality, skin disease and other health problem	Training on alternate and modern jute retting techniques, government policy against jute retting in the beel water	9
10	Use of high doses of pesticides and fertilizer	Water pollution, fish disease and fish mortality	Provide training on IPM, compost making	10
Stakeholder Group: Farmers				
1	Inundation during monsoon and lack of water for irrigation during dry season result in single crop cultivation and high risk	Crop production declining	Water regulatory structure for managing water for fishes and crops	1
2	Excessive amount of water hyacinth enters into the beel	Expensive to clean fields for dry season cultivation. Water hyacinth propagates quickly and takes space of other aquatic plants and animals that disappeared (used as vegetables and duck feed).	Water regulatory structure for controlling water hyacinth, training on use of water hyacinth	2
3	Entrance of saline water during dry season	Destroys standing crop at the mature stage	Water regulatory structure for controlling saline water entrance in the beel during dry season	3
4	Over exploitation of aquatic resources	Loss of livelihoods dependent on aquatic resources	Impose local rules including temporary ban period during snail breeding period	4
5	Use of different harmful gears to catch fish	Very low fish population and diversity	Impose local rules including government policy on use of	5

	Problems	Effect	Solution	Rank
			monofilament and small mesh nets	
6	Lack of quality seeds and knowledge on good production practices	Low crop production	Awareness raising, training and supply of quality seeds from genuine sources	6
7	High wave action erodes bank of the internal canals	Loss of agricultural land	Plant deep rooted trees, shrubs and vetiver grasses	7
8	Fishes cannot enter into the beel during breeding period due to wave action	Fish declining	Use of current resistant structure, plant deep rooted trees, shrubs and vetiver grasses by the side of the canal	8
9	Fish escapes through open canal due to lack of shelter for fishes	Fish declining	Establish fish sanctuary and make deep pool in the canal	9
10	Fish catch during breeding season	Very low fish population and diversity	Imposing local rules including temporary ban period during fish breeding period, alternate livelihoods	10
11	Lack of knowledge on management of wetlands and wetlands resources	Wetlands degrading	Training, exposure visit and experience sharing	11
Stakeholder Group: Landless				
1	Unpredictable water flow in the adjacent river over different seasons	Inundation during monsoon and lack of water for irrigation during dry season results in cultivation of only one high risk crop, reduces work opportunity for poor	Temporary water regulatory structure for conserving water for fish and crops	1
2	Water logging	Land remains fallow throughout the year, limited	Construct water regulatory structures	2

	Problems	Effect	Solution	Rank
		work for farm labourers		
3	Fish cannot breed in the beel due to lack of knowledge and initiatives for conservation measures	Very low fish population	Establish fish sanctuary and make deep pool in the canal	3
4	Catching brood fish by fishers and non fishers	Fish declining, loss of livelihood	Arrange alternate livelihoods for fishers and non-fishers so they can observe ban period when fish and other aquatic animals are breeding	4
5	Use of different harmful gears to catch fish	Very low fish population and diversity	Impose local rules including government policy on use of monofilament and small mesh nets	5
6	Loss of aquatic biodiversity due to unregulated water flow into the beel	Fish and other aquatic resources declining, loss of livelihoods of the poor	Water regulatory structure	6
7	Jute retting in the beel water	Water pollution, skin disease and other health problem	Training on alternate and modern jute retting techniques, government regulations	7
8	Excessive water hyacinth enters into the beel during monsoon	Water hyacinth grows quickly and takes space of other aquatic plants and animals resulting in disappearance of different plants (use as vegetable) and animals (duck feed), hard labour to clear water hyacinth	Water regulatory structure for controlling water hyacinth	8

	Problems	Effect	Solution	Rank
9	Fish escape through the open canal to the river during low tide	Low fish diversity	Establish fish sanctuary and make deep pool in the canal	9
10	Lack of quality seeds and knowledge on good production practices	Low crop production, less income	Awareness raising, training and supply of quality seeds from genuine sources	10
11	High current in monsoon prevents conservation of fishes	Very low fish population	Establish fish sanctuary and make deep pool in the canal	11
12	Canal bank erosion due to high current in the river	Loss of agricultural land	Stabilize canal banks with tree plantation and temporary bank protection work	12
13	Saline water enters into the beel when crops are mature	Destroys standing crop at the mature stage, loss of livelihoods	Water regulatory structure to control entry of saline water in the beel	13

Based on the separate stakeholder discussions a common set of potential management actions was identified and ranked according to the views of the different stakeholders (Table 3.2).

Table 3.2 Management actions suggested by community for Korgar floodplain during PAPD

Actions	Time	Responsibility
Formation of beel management committee (BMC)	August-September 2006	Community
Monthly meeting	Continuous	BMC
Annual general meeting	Not set	BMC
Training needs assessment	September 2006	Community /Research team
Training	December 2006	Local experts(from other communities, local government agencies)
Open theatre and preparation of	December 2006	Community/local theatre

Actions	Time	Responsibility
billboards to make people aware about fish conservation and rehabilitation		team
Exchange visit	December 2006	BMC/Research team
Build temporary water control structure	February –April 2007	Local Government Engineering Department/community
Establish experimental sanctuary	February –April 2007	community
Training	November-December 2006	
Stop using harmful gear	July-August 2006	Community/Department of Fisheries
Introduce less water demanding crops	February –April 2007	Community
Clear excessive water hyacinth	September-October 2006	Community
Good seed supply	November-December 2006	Community/Department of Agricultural Extension
Savings scheme	Monthly	BMC
Open an account	January 2007	BMC
Introduction of lost species	May 2007	BMC/Community/DoF

Table 3.3 summarises the priority management actions suggested by the community during the PAPD.

Table 3.3 Priority management actions for Korgar floodplain from 2006 PAPD.

IFM options	Ranking on the basis of scores (average of groups)
Water regulatory structure	1
Establish fish sanctuary and make deep pool in the canal	2
Restrict use of different harmful gears to catch fish	3
Rehabilitation of locally extinct/rare species	4
Awareness raising, training on conservation of fish and other aquatic resources, adopt conservation measures	5

Adopt closed season for fishing in spawning time	6
Arrange alternate livelihoods for fishers and non-fishers during fish and other aquatic animal breeding period, observe ban period during that period	7
Alternate/additional crop cultivation	8
Communication and linkages with other institutions	9

1 = top rank overall, etc.

This indicated a high interest in installing a water control structure which can regulate water flow, saline water and water hyacinth intrusion. For conservation of fish and other aquatic plants and animals interventions to directly limit fishing effort ranked higher (for example a community fish sanctuary and rehabilitation of locally extinct/rare species).

The rules and norms for **aquatic resources management** proposed by the community can be summarized as follows:

- Prohibit fishing and collection of snails in the months of Boishak-Jaishtha-Ashar (mid-April-mid July)
- Cannot fish more than twice by dewatering *kua* (ditches) in the months of Falgun-Chaitra (mid February-mid April)
- Cannot use current net (nylon monofilament gill net) or other destructive net or gear with mesh size less than one inch
- Cannot fish by using flap gate (a gate made of bamboo and plastic which moves with the height of water) in the canal
- Cannot use pata jal (bamboo fences) across the canal
- Cannot use set bag net at the mouth of the canal.

Proposed rules and norms for **crop management** can be summarized as follows:

- Cultivate more short duration crops
- Cultivate more crops other than paddy in high and medium high lands
- Use ribbon retting of jute and also ret jute outside the beel
- Open sluice gate earlier.

The options were assessed in more detail by the stakeholders in the PAPD. Their different assessments did not differ much between stakeholders and have been consolidated in Table 3.4

Table 3.4 Consolidated assessments of IFM options by different stakeholder groups (in priority order).

|IFM options	Benefits	Dis-benefits	Dis-benefited groups	Solutions	Way forward
Build water regulatory structure	♦ Save fish, restrict saline water and water hyacinth intrusion in the beel ♦ Better regulation of water for agriculture and fishery	None	None	♦ In the PAPD the local head of Local Government Engineering Department was present and he mentioned that the LGED planned to build a sluice gate and embankment along the entire river, but the date is not yet known. The local community could build a temporary structure to save fish and crops	♦ Build a temporary structure within next dry season
Establish fish sanctuary and build deep pool in the canal	♦ More fish catch, biological diversity and conservation of fish	None	None	♦ Lease existing kua (ditches)	♦ No money to do it this year. ♦ Discuss how to manage money for sanctuary
Restrict use of different harmful	♦ More fish and increased biodiversity	None	None	♦ Take help of local government department for	♦ Awareness building among community

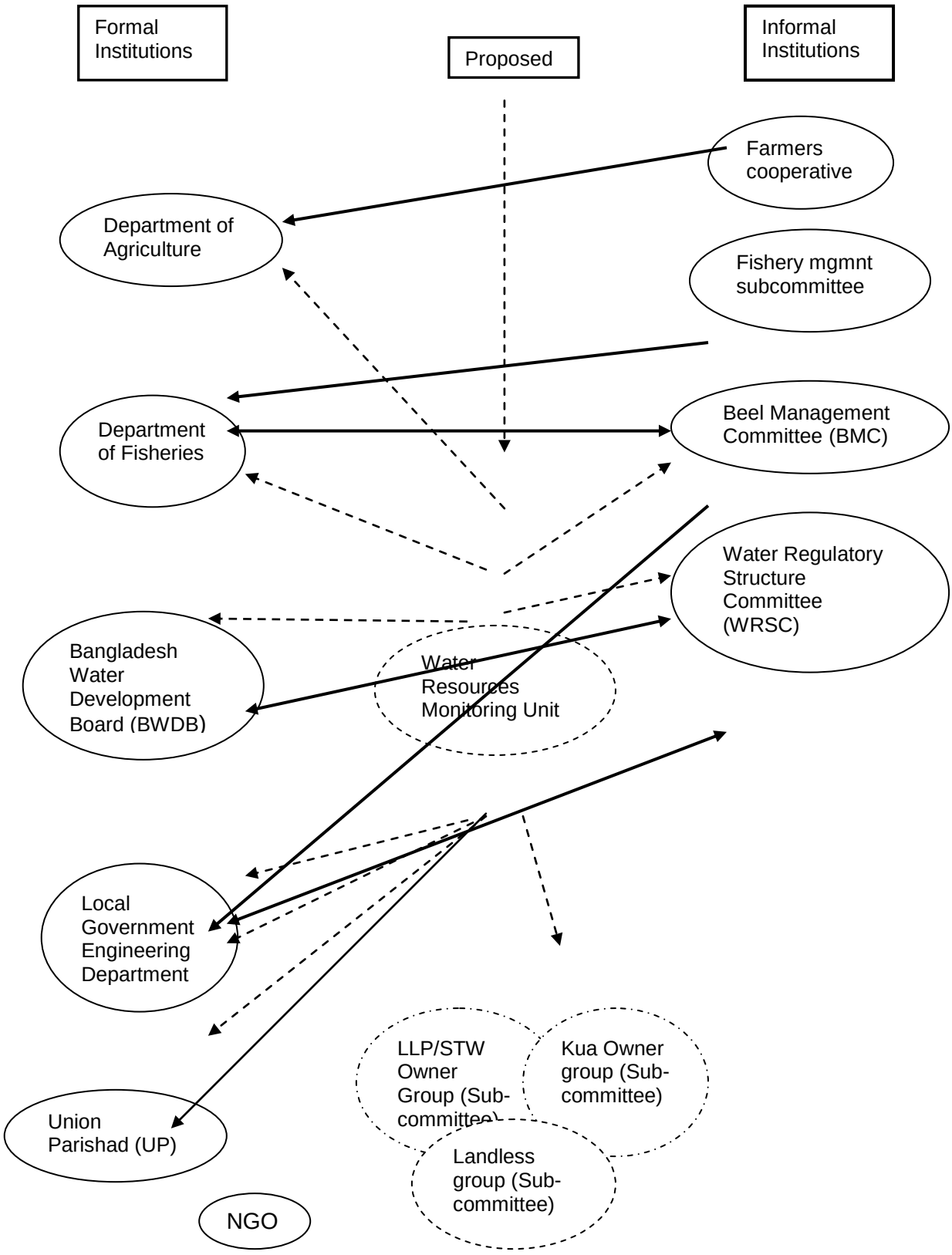
IFM options	Benefits	Dis-benefits	Dis-benefited groups	Solutions	Way forward
gears to catch fish				establishing policy regarding use of harmful gears	members, campaign against use of harmful gears
Awareness raising, training on conservation of fish and other aquatic resources, adopt conservation measures	♦ Community aware of the rules and protect fishery	None	None	♦ Raise awareness among the community through different media	♦ Prepare billboards with messages, arrange open theatre, take part in different rallies, workshop, meetings etc.
Closed season when fish are spawning	♦ More fish and increased biodiversity	Professional fishers have to find alternate way of income but they will earn more after closed season	Professional fishers	♦ Alternate livelihoods for fishers, training and credit	♦ Agree closed season period, need assessment, skill assessment and market survey for alternate livelihoods and arrange training
Alternate crop cultivation (dry season)	♦ Less irrigation ♦ Less cost of production ♦ Soil fertility increases ♦ Low investment,	None	None	None	♦ Crop demonstrations ♦ Find sources of good seed ♦ Training ♦ Awareness

IFM options	Benefits	Dis-benefits	Dis-benefited groups	Solutions	Way forward
	high return ♦ Less demand for water ♦ Less competition among different water users ♦ Timely opening of sluice gate for fish recruitment ♦ No environmental pollution due to less pesticide use ♦ Less family labour engagement				raising
Rehabilitation of locally extinct fish species	♦ Biodiversity increases ♦ More fish production ♦ More income	None	None	♦ Restock rare/locally extinct species	♦ Collect those species and release them in temporary pond before releasing them in permanent sanctuary
Communication and linkages with other institutions	♦ Exchange of knowledge ♦ Good relationship ♦ Conflict resolution ♦ Coordination among neighbouring beels	None	None	None	♦ Workshop ♦ Newsletter ♦ Network ♦ Exchange visit ♦ Guidelines for IFM ♦ GO cooperation

As can be seen, out of these options fish sanctuaries, cultivating alternative dry season crops, reintroduction of fish species, improved linkages and communications, and awareness raising were seen as having no harmful effects for any local stakeholders and therefore should be easier to implement. However, a closed season would need some compensating support for fishers during that period.

Lastly the stakeholders during the PAPD considered what local organisations and institutions might be involved in improving management of the floodplain and how they should interact. It is notable that most local informal committees and institutions had links only with one or at best two sponsoring formal bodies/government agencies (Fig 3.1), and were seen as acting in an uncoordinated way by the participants. The proposal at this time from the participants was to form a water resources monitoring unit that would include representatives from or links with all of the stakeholders and institutions and could then help coordinate activities. However, as will be seen the eventual outcome in 2007 was that the committee took on part of this role by comprising of representatives from the other local institutions and stakeholders, and having good links with all the concerned government departments at the local level.

Fig 3.1 Institutions and linkages assessed in plenary through PAPD.



CHAPTER 4:
BASELINE SURVEY

A baseline survey was carried out in July 2006 to understand the current socio-economic situation of the households living around the beel, their use of land and water for their lives and for their livelihoods, their dependency on those resources, and their views on biodiversity, conservation and issues related to sustainable integrated floodplain management.

A total of 429 people live in 89 households surveyed, with an average household size of 4.8. Of the total 89 households surveyed, 89% are Hindu, 50% of the total population are male and 50% female. About 65% of the population are effectively or almost illiterate and cannot or can barely read or write (Table 4.1), including those who went to school at their early age but have since forgotten everything. Some of the women who are NGO members have learned how to write their name.

Table 4.1 Education level of members of sample households

Level	%
Illiterate	27.5
Can sign	18.9
Primary	18.9
Secondary	26.6
Higher secondary	4.9
Graduate	2.1
Masters	1.2
Number of people	429

Land ownership showed a linear pattern in the project area (Table 4.2). More than fifty seven percent households hold less than one acre land. Lands in the project area are not productive very. Land owners can only cultivate one crop in a year, but the cultivation cost is high. Fifty one percent of the households own 87% of the land.

Table 4.2 Land ownership of all households.

Category	Land area owned (decimals)	Frequency	Percent
Absolute landless	0	26	11.82
Landless (NGO criteria)	0 1-50	57	25.91
Functionally landless	51-100	41	18.64
Small holders	101-250	54	24.55
Medium holders	251-750	34	15.45
Landlord	>750	8	3.64
Sample size		220	100

100 decimals = 1 acre = 0.4047 ha

The primary occupation of the people in the area is influenced by the environment within the beel area. However, a high percentage of the total population are either housewives, students, old and inactive, or children not yet in school. They are not involved in any economic activities other than helping the main earners in their household. About half of the active population is involved in farming either in their own land or on land cultivated on share-cropping basis land, or in both types of land. As most of the population are low caste Hindus and a bigger part of them were involved in fishing in the past, due to unavailability of fish and the changed environment these full time fishers changed their profession and started other jobs. However, availability of other non-farm jobs in the area is very limited, except for some skilled work such as carpentry, masonry or blacksmith. Teaching in NGO run schools or in primary level school in the area was evident but not highly paid (Table 4.3). Some people work as agriculture labourers in addition to farming their own land. This is especially true for the small land holders. About two-fifths of the population have a secondary occupation. Out of all the people who have a secondary occupation, more than 40% are involve in livestock rearing and 13% are involved in fishing.

Table 4.3 Occupation of all household members

Occupation	Primary occupation			Secondary occupation	
	Frequency	Percent of total population	Percent of active population	Frequency	Percent of active population
Cultivate own land	49	11.4	35.8	22	5.1
Cultivate own and sharecrop land	17	4.0	12.4	4	0.9
Sharecropper only	8	1.9	5.8	6	1.4
Fishing	7	1.6	5.1	23	5.4
Fish culture				1	0.2
Fish trader	2	0.5	1.5		
Livestock	3	0.7	2.2	76	17.7
Poultry rearing	1	0.2	0.7	11	2.6
Agricultural labourer	15	3.5	11.0	20	4.7
Non agricultural labourer	6	1.4	4.4	5	1.2
Rickshaw/van	1	0.2	0.7		
Handicraft	2	0.5	1.5	2	0.5
Petty trade	10	2.1	7.3	7	1.6
Carpenter/mason/blacksmith	7	1.6	5.1	3	0.7
Teacher	6	1.4	4.4		
Government service	2	0.5	1.5		
Other employee/Non government service	1	0.2	0.7		
Sub total	*137*	*31.9*	*100*		
Housewife	112	26.1			
Student	113	26.3			
No activity	37	8.6			
Children not yet in school	31	7.2			
Subtotal	*293*	*68.3*			
Total	429	100		180	42.0

About 6% of the total female population are involved in economic activities as their primary occupation such as agriculture and livestock rearing. A bigger percentage of women (38%) are doing economic activities as a secondary occupation, they regard

household care as their primary activity. These women are involved in livestock rearing, collection of aquatic resources, homestead gardening, post-harvest activities, on and off-farm labouring, handicraft making, poultry rearing and snail collection (Table 4.4). It was found in the survey that women are the main users of natural resources and they care about bio-diversity.

Table 4.4: Involvement of women in different economic activities

Activity	Count
Livestock rearing (e.g. goats, cattle)	32
Poultry	25
Homestead gardening	6
Labouring (agricultural and other)	4
Handicrafts	4
Collection of aquatic resources	2
Snail collection	1
Post-harvest work	2
Milk sale	2
Teacher	2
Number	80
% of women	38

Housing condition as an indicator for economic status was also evaluated during the baseline survey. Most of the households have single room or multiple room homes with a tin roof of low quality (Table 4.5). In the last decade straw and leaves were used by the poor households for roofing. These materials needed frequent change due to rotting. Now poor people use cheaper tin as roof material as the natural leaves they were using became rare and straw is now sold by the farmers, whereas before they could have straw free of cost. The other reason is introduction of HYV rice which produces shorter straw. About 9% of the households used good quality tin materials or concrete for roofing houses. These are well off households.

Table 4.5: Type of housing owned by all households

Type	Frequency	Percent
None	1	0.5
One thatched bed/storage room	4	1.8
Multiple room with thatch roof	3	1.4

One room with tin (cheap) roof	125	56.8
Multiple room with tin (cheap) roof	67	30.5
Concrete/tin (expensive) roof	20	9.1
Total	220	100

Very few people are fully dependent on fishing for income (Table 4.6). The decrease in local fishery resources has turned past full time fishers into part time fishers. People complained that neither the community nor government took any initiative to conserve aquatic resources nor the result is declining fishery resources. One third of the people never fished. These are well off people who think fishing is not a prestigious activity even for consumption. However, with the declining fishery, as expected people have less dependence on fishing for an income, yet about half of the households are subsistence fishers.

Table 4.6: Household dependency on fishing

Involvement in fishing	Frequency	Percent
Not fishing	29	32.6
Fish for income (full time)	8	9.0
Fish for food	48	53.9
Fish for food & income(part time)	4	4.5
Sample size (households)	89	100

Korgar Beel lies under water for about six months in a year. About 40% of the households are dependent on different aquatic resources for their livelihoods (Fig 4.1). Besides fishing, collecting aquatic plants and fruits, snails, collecting fodder and grazing cattle are important for resource users. Usually men are involved in fishing, grazing cattle, collecting fodder and collecting aquatic plants; women graze livestock and collect snails, aquatic plants and fruits. Snail collection became a business for the last decade. These snails are supplied to the shrimp farms as feed. People also collect crabs for income. Crabs are a high value product. Aquatic plants such as water lily and fruits are used as food and people collect and sell those.

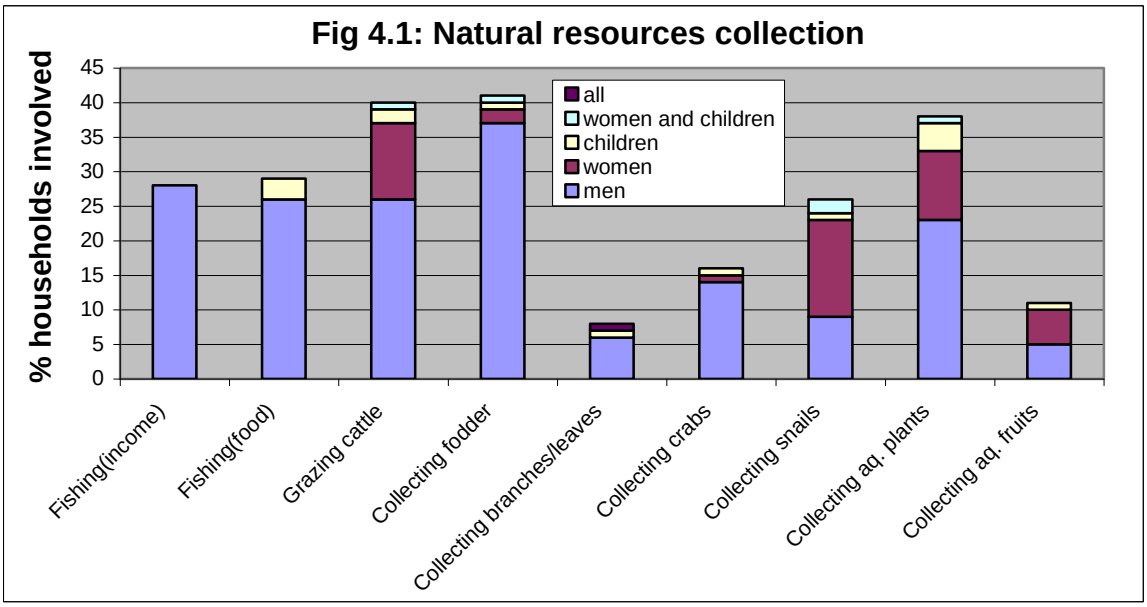


Table 4.7 shows household's reported food security. It was observed that more than half of the households report that they face food deficiency in some months of the year. Some households also have members who work outside the area and earn from different sources, these people are just surviving without much problem (break even). Only 11% of the households who typically own bigger landholdings and have earnings from sources other than agriculture are surplus in food.

Table 4.7: household food sufficiency

Food sufficiency	Number of households	%
Usually food deficit	18	20.2
Occasionally deficit	32	36.0
Break even	29	32.6
Surplus	10	11.2
Total	89	100

In the past fish was considered as a free source of protein for rural Bangladeshi people. Everyone had free access to fish in any flooded land during the monsoon in floodplain areas. With the change in time still land owners do not prevent people from fishing in their flooded fields unless they use the land for aquaculture. Very few people who have capacity to buy fish but do not fish for consumption eat fish everyday or at least every week. A high percentage of households reported fish

consumption the during monsoon when natural fish are treated as an open access resource. About one-third of the households reported fish consumption as a rare event (Table 4.8).

Table 4.8: Fish consumption frequency

Frequency	Number of households	Percent
Most days	2	2.3
Every week	1	1.1
At least every month	2	2.3
Seasonally	51	57.3
Rarely	33	37.0
Total	89	100.0

During the survey respondents opined that to improve aquatic resources in the beel area a proper water management system needs to be established (Table 4.9), which includes water a regulation structure, embankment and a beel management committee. This committee, according to them should work as a central committee which will support other subcommittees such as fishery subcommittee, agricultural subcommittee, sluice gate management subcommittee, farmers' field school, etc. The fishery management committee in cooperation with the government agencies should enforce a ban on use of harmful gears, stop catching of brood fish during the breeding season (April-June), establish a sanctuary to conserve wild fish, and rehabilitate and re-introduce locally extinct and rare fish species. Awareness campaign, according to the respondents, is a major tool for information dissemination. They think an information centre for the villagers would help to improve agriculture, fishery and livestock production and returns by providing information on new techniques, inputs, markets, etc. Pesticide use has been increased many fold for cultivation of HYV paddy. They see this as a threat for aquatic resources as leaching of pesticides into nearby canals kills aquatic animals and also contaminates other living aquatic resources. Women respondents raised other needs such as electricity, roads, alternate sources of income and unity among villagers.

Table 4.9: Community needs reported in household survey

Needs	Men		Women	
	Frequency	%	Frequency	%
Water regulatory structures	89	100.0	89	100.0
Committee formation	75	84.3	72	80.9
Stop catching brood fish	27	30.3	23	25.8
Conservation of wild fish	12	13.5	21	23.6
Sanctuary establishment	11	12.4	18	20.2
Ban harmful gears	7	7.9	10	11.2
Proper implementation of fishery law	7	7.9	11	12.4
Controlled use of pesticide	3	3.4	3	3.4
Awareness building	1	1.1	2	2.3
Rehabilitate extinct/rare species	1	1.1	0	0.0
Road	0	0	34	38.2
Alternative income generating activities	0	0	12	13.5
Electricity	0	0	13	14.6
Unity	0	0	12	13.5
Total sample	89	100	89	100

Table 4.10 showed the constraints on development and on addressing their needs identified by the respondents. The main constraint they identified was proper initiative. Both community and concerned government agencies have not taken any initiative in the past to resolve the problems identified during the PAPD workshop. According to the respondents some of the initiatives need proper knowledge such as building water regulatory structure or establishing fish sanctuary. During PAPD the research team invited local government officials who explained that they have not been able to implement such measures due to budget constraints, but it is in their agenda. Laws against degrading biodiversity are part of the needs to support restoration of aquatic resources. Some such laws and policies are in place but implementation needs help from law enforcement agencies and the Department of Fisheries. But the community did not initially see that there is much that they could do themselves to abide by such principles. Awareness among people is also a vital pre-requisite, and could be addressed through different media used by the community.

Table 4.10: Community constraints

Constraints	Frequency	%
No control over/management of water resources	89	100.00
No proper initiative from government or community to improve water resources	68	76.40
Lack of information	38	42.70
Lack of knowledge	34	38.20
Lack of awareness	10	11.24
Lack of united effort	10	11.24
Lack of law enforcement	5	5.62

CHAPTER 5:
INSTITUTION BUILDING

Participatory planning, Korgar Beel

For better management of the resources of Korgar Beel, based on the outcomes of the PAPD and the individual opinions from the household survey, local organizations and institutions needed to be developed which in the long run will become recognized institutions for local management of aquatic resources in the beel. Accordingly the team helped facilitate formation of a 15-member Beel Management Committee (BMC) in September 2006. The members are from different stakeholder groups - fishers, farmers, landless and women. The community in a general public meeting decided on the composition of this committee. The BMC is composed of one chairperson, one vice-chairperson, one secretary and 12 general members. This committee then formulated its strategy for managing and setting rules on fishing in the beel. They made their own rules for a closed season, a ban on harmful gears, membership fees and savings. As the committee consists of people from all categories enforcing the fishing rules has been relatively easy. They also have a three member advisory committee consisting of one officer from the Department of Fisheries, one of the project research team, and one representative from the local NGO Banchte Shekha. The main activity of the BMC in its first nine months of operation has been to take up fish conservation measures. The BMC is also responsible for coordination with other stakeholder groups as well as other organisations active in the area.

CHAPTER 6:
AWARENESS BUILDING

Beel management drama, Korgar Beel

An open air drama on resource use, exploitation, management, linkages with government agencies, and biodiversity management was staged in November 2006. The script was prepared in local language and a local theatre group was involved to perform the drama. After a week's rehearsal the group performed the drama in the open area of a local school. Before staging the drama local people were informed through miking (rickshaw-mounted loud speakers) and personal contacts. Each of the committee members took responsibility of informing people in their own para (sub village). Almost all households in the area saw the drama. A KAP (Knowledge, Attitude and Practice) survey was done before and after the drama and after formation of the beel management committee. The result is shown in Annex-1.

Following this, the BMC helped place bill boards in different spots in the area with messages on the usefulness of better floodplain resources and biodiversity management.

CHAPTER 7:
KNOWLEDGE SHARING

Members of Korgar Beel community on exposure visit on IFM

7.1 Training

Training on leadership and in agricultural best practices was arranged with help from local experts from the community, local staff of the concerned government departments, and a local NGO (Banchte Shekha). In the leadership training four Korgar Beel Management Committee (BMC) members and in the other training 20 community members attended. These two trainings were done according to a schedule prepared by the BMC. Despite these trainings, the community wishes to have more training. The Department of Fisheries was pleased with the activities of the BMC and their enthusiasm, and gave fries of some locally rare fish species to the BMC through local government representative for release in the beel. The BMC has encouraged the community to mobilize to access local resources, and to establish their rights to public resources. As a result the local school committee allowed the BMC to preserve those fries temporarily in a small pond belonging to the school committee. This pond retains water throughout the year. However, the community opined that they need permanent sanctuaries to protect fish in the beel. Fishery resource management and sanctuary management training were held in January 2007.

7.2 Exposure visit

In 2006 two exchange visits were arranged, one to Barnal-Silimpur-KolaBasukhali Beel (BSKB – a floodplain beel) in Kalia, Narail District comprising 25 farmers , 2 officials and 2 NGO workers, and another to BKSB in Terokhada, Khulna District (another part of this large floodplain in southwest Bangladesh) comprising 20 farmers, 1 official, 1 NGO staff. Through the visits the people from Korgar were able to teach with the local fishers committees in BKSB who are conserving fish and already re-introduced some locally rare fish species. Both the areas are floodplain beels and have a similar environment to the project area. All the visit participants arranged a workshop on 21 March 2007 at Korgar Beel to exchange views and experiences from the visits with the rest of the community. They requested further such visits.

7.3 Reflective learning

In April 2007 five stakeholder groups have separately evaluated their activities and the IFM project related activities on the basis of progress, participation, attitudinal change and benefits. The groups were:

1. Beel (IFM or resource) Management Committee
2. Farmers
3. Fishers
4. Kua owners
5. Local government Institutions (Department of Agricultural Extension, Department of Fisheries, Local Government Engineering Department, Bangladesh Water Development Board) plus NGO (Banchte Sheka).

The outcomes of the sessions are consolidated in Table 7.1.

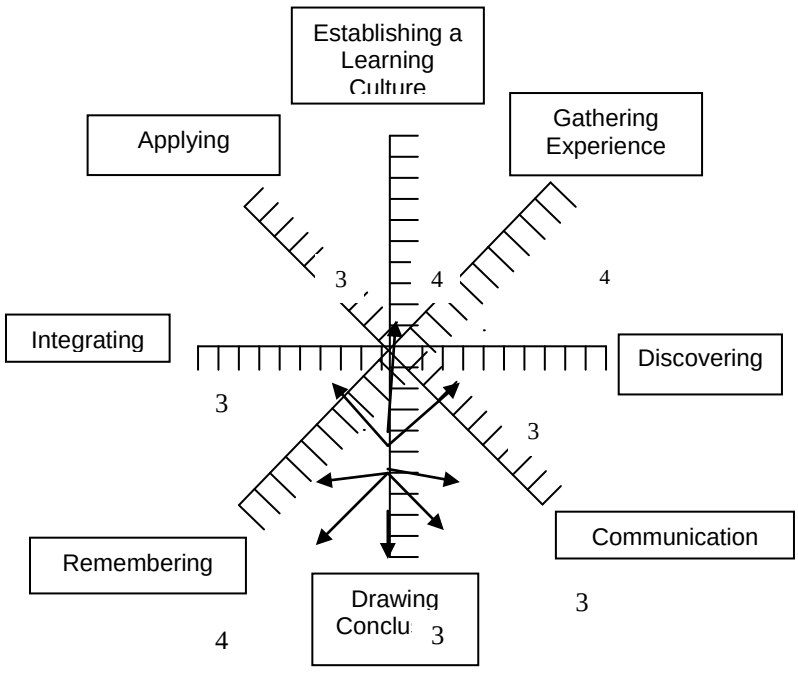
Table 7.1 Consolidated outcomes of the sessions – lessons reported by the participants.

Reviewed Activities	Learning	Who does this	When done
Formation of BMC committee	There was no coordination between different stakeholder activities in the area. Their activities were also not so well organized. The ongoing project, project personnel, local government and NGO were each following their own agenda. Bringing fishery and agriculture development under IFM has effectively improved management and coordination in the floodplain. Activities related to fishery and agriculture should progress through sub-committees. Sub-committees can independently take decisions concerning specialized activities but should discuss with the IFM committee before implementation. A sluice gate sub-committee and bund management sub-committee will be formed.	Beel Management Committee	2006
Closed season	A 3-months closed season from Baishak (Mid April) to Ashar (Mid July) it was hoped will facilitate fish breeding and avoid catching of small / juvenile fish.	BMC, Fishers and community	Annually
Communication and linkages with other institutions	All the Go/NGO institutions in the area are now better coordinated. BMC includes all stakeholder categories from the community. Departments of Fisheries, Agriculture Extension, LGED and BWDB are in constant coordination with the people and BMC committee.	BMC, Departments of Fisheries, Agriculture, LGED and BWDB	Through-out the year
Knowledge sharing	2 exchange visits have facilitated 45 farmers to visit other areas. They shared their experiences, gained new knowledge about agriculture and fishery and decided to try growing some new crops such as wheat, garlic and spices in smaller plots.	Project personnel, NGO staff, staff of Department of Fisheries, local community	Annually

Reviewed Activities	Learning	Who does this	When done
		and committees	
Awareness raising	Local theatre group made one open air performance in the area that contained beel resource management messages, which attracted a huge audience and has helped raise awareness on Integrated Floodplain Management.	Local theatre group, project personnel, BMC committee	Annually

The participants in the lesson learning sessions were asked to score the achievement of project activities against eight basic learning principles. The different stakeholders in the committee were asked to give a score between 1 and 10 against each of those learning principles for the status of their newly gained experiences. The criteria were those they think are necessary for assessing their strengths and weaknesses in the learning process. The average scores from the different groups are shown in Fig 7.1. Strengthen and weaknesses were determined from their scores – in all dimensions the scores were in the lower middle of the possible range, which indicates substantial progress in just under a year of working with the community to establish learning processes regarding IFM.

Fig. 7.1 Organisational assessment of learning (average scores)



7.4 KAP survey on floodplain residents of Korgar Beel

Introduction and Method

In November 2006 a total of 89 residents of Korgram were interviewed before they attended an open air folk theatre presentation on IFM and again about a month after the event in December 2007 using the same “knowledge, attitude, practice” (KAP) survey schedule. The respondents were on average 40 years old, all had attended school for at least one year and roughly 34% had education to class six or higher, all but five were Hindu, their average landholding was about 1 acres (0.40 ha), about 54% gave their primary occupation as farming and 22% as fishing. This is broadly typical of the Korgram site community, although all of the participants there are Hindu. The project activities were at an early stage with a limited interaction with the community and the environment.

The surveys comprised of statements which the respondents were asked how strongly they agreed or disagreed with, how important or unimportant they were, etc. In each case five categories were used. For statistical tests these were converted to scores of 1 to 5.

The appropriateness of the responses compared with the knowledge and attitudes that the project sought to develop and strengthen were also assessed by the research team to see if the knowledge and opinions expressed by the respondents matched with project messages including those in the theatre production.

Results

The respondents’ opinion on aquatic resources management is shown in Table 6.1. All the respondents opined that aquatic resources are declining due to water salinity, backflow, lack of conservation and habitat management, lack of awareness about fishery management and use of pesticide. They think community has a responsibility to save the biodiversity but none showed any interest. About 70 percent respondents complained that their knowledge about resources management is limited and they expected that they receive training from the government agencies. The respondents also opined that community should have some rules for aquatic resources management but that needs an organized community to formulate and implement which was absent during the survey. About 40 percent respondents also opined that

fishers should have right to use any gear they like to use. However, rest 60 percent think fishers should use only harmless gears. It was discussed by the elders that 20 years back there were more full time fishers in the beel area and they were from Hindu community. Now-a day's only few depend on fishing for income. Although number of full time fishers decreased, subsistence fishers may have increased in the area. People fish for food in the monsoon when fish enters into the beel from the river. Farmers are interested to introduce new crops but they don't have access to technology and information.

Respondents believe that majority of the households in the village are poor. A small percentage of households have wealth but compared to the urban life they should not be considered as rich. Those (37 percent) who believe that overall well being of households improving also in favour of the statement that household income increased. However, rest of the respondents does not agree fully that overall household well being changed due to increased income. They think income may have increased due to diversified sources of income, but income is not proportionate to the expenditure. Therefore, household savings has not been built.

Overall since the surveys conducted before and after folk theatre presentations on Integrated Floodplain Management (IFM) with only a month between the interviews, there was too little time for attitudes to change to any great extent. Therefore for some of the issues and statements scored changes between for example strong agreement and agreement should not be considered as important, they may just show that respondent's views fall in this range. It is changes between the main categories of response (for example, agree changing to not sure or disagree) that are important to assess.

Thus knowledge of the floodplain ecosystem did not change greatly, except that some people became less convinced of the use of rabi crop diversification, while more people became convinced that community should manage biodiversity (Table 7.2). It is to mention here that no interventions have taken place in the study area except awareness campaign.

Perceptions of the trends in floodplain natural resources should not change following such an event, since the participants are known to make use of these resources. Those changes reported may not be a direct response to the theatre, but a realization that things had been getting worse than they were willing to say before

(Table 7.3). Overall it is apparent that over the last 20 years fish species diversity, including large fishes, dry season water area, pollution, and quantities of aquatic plants have all been declining. Answers on conversion of beels to crop land are ambiguous considering the reported loss of dry season water. Fish catches gave a split response. Areas of all major crops in the monsoon reportedly have fallen, although some increased diversification was noted by over half the respondents.

Table 7. 2 Knowledge about floodplain ecosystems and their management (biophysical features) % of responses

Statement		Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree
Floodplain ecosystem includes only seasonally inundated lands	Pre	96.1	3.9	0	0	0
	Post	61.5	34.6	0	0	3.8
Aquatic resources are declining	Pre	82.02	17.98			
	Post	96.12	3.88			
The community should manage biodiversity	Pre	33.71	66.29			
	Post	82.29	17.71			
There should be some rules for aquatic resources management	Pre	26.67	73.03			
	Post	40.3	59.7			
Number of full time fishers declined in the area	Pre		53.93	17.98	28.07	
	Post	1.3	71.91	22.89	3.9	0
Dry season water management is important for crop and fish production	Pre	94.9	5.1	0	0	0
	Post	62.3	35.1	2.6	0	0
Wet season water management is important for crop and fish production	Pre	69.6	25.3	1.3	0	3.8
	Post	77.9	14.3	3.9	3.9	0
People get only crop and fish from floodplains beels	Pre	5.1	11.4	0	17.7	65.8
	Post	5.2	11.7	0	37.7	45.5
Only fishers and landowning farmers are the beneficiaries of floodplain resources	Pre	1.3	5.1	0	20.3	73.4
	Post	3.9	3.9	3.9	31.6	56.6
*Siltation contributes to the degradation of floodplain habitats**	Pre	55.7	44.3	0	0	0
	Post	40.3	50.6	5.2	0	3.9
Limiting fishing effort is one way of reverting declining fish catch	Pre	98.7	1.3	0	0	0
	Post	83.1	16.9	0	0	0
Wetland (fish) sanctuaries will contribute	Pre	98.7	0	0	0	1.3

to the rejuvenating fish stocks and protecting biodiversity	Post	96	2.7	1.3	0	0
Rabi crop diversification can contribute to protection and maintenance of floodplain fish stock	Pre	52.6	27.6	5.3	6.6	7.9
	Post	89.7	9	0	0	1.3
People grow boro rice in beel areas as other crop is not suitable there	Pre	3.9	11.7	2.6	14.3	67.5
	Post	0	3.8	0	17.9	78.2
Most of the villagers are poor	Pre	2.23	71.91	20.22	4.49	1.12
	Post	2.24	78.65	19.01		
Overall well being of your household improving	Pre		37.08	25.84	33.71	3.37
	Post		33.71	22.47	43.82	
Household income increasing	Pre	1.12	35.96	25.84	33.71	3.37
	Post		61.8	16.85	21.35	
Information not available	Pre	1.12	48.31	29.21	20.22	1.12
	Post	10.11	78.65	11.23		
Knowledge of fishery limited	Pre	6.74	64.04	21.35	6.74	
	Post	20.22	79.88			

t-test of difference of means pre and post, after combining strongly agree and agree, strongly disagree and disagree:

bold indicates significant difference ($p<0.05$) in expected direction,

italic indicates significant difference ($p<0.05$) in opposite direction.

All other indicators – no significant change in scores

Table 7.3 Changes in the floodplain environment taken place during last 20 years

Indicator	Rating	Pre %	Post %
Fish Species diversity	Increased	44.3	7.6
	Decreased	55.7	92.4
	Almost extinct	0	0
Availability of large fish (year1, year2 and above age group)	Increased	24.1	1.3
	Decreased	73.4	83.5
	Almost extinct	2.5	15.2
Area of boro (dry season paddy) rice cultivation	Increased	9.1	2.5
	Decreased	90.9	93.7
	Almost none	0	3.8
Diversification of crops (other than boro rice) in beel area	Increased	65.4	54.4
	Decreased	34.6	44.3
	Almost none	0	1.3
Dry season water cover	Increased	32.9	9.1
	Decreased	67.1	76.6
	Almost none	0	14.3
Water pollution	Increased	11.4	5.1
	Decreased	87.3	94.9
	Almost none	1.3	0
Soil fertility	Increased	24.1	59.5
	Decreased	75.9	27.8
	Almost none	0	0
	Not sure	0	7.6
	No change	0	5.1
Conversion of beels in to crop lands	Increased	2.6	5.2
	Decreased	97.4	93.5
	Almost none	0	1.3
Production of natural fish	Increased	56.4	51.9
	Decreased	43.6	45.5
	Almost none	0	1.3
	Not sure	0	1.3
Avenue for fish migration from river to	Increased	46.8	16.7

beels	Decreased	51.9	78.2
	Almost extinct	1.3	2.6
	Not sure	0	2.6
Abundance of aquatic vegetations used for human fodder	Increased	0	11.5
	Decreased	100	88.5
	Almost extinct	0	0
Abundance of aquatic vegetations used for animal fodder	Increased	0	1.3
	Decreased	100	93.6
	Almost extinct	0	5.1
Abundance of aquatic vegetations used for fuel	Increased	2.6	16.5
	Decreased	97.4	70.9
	Almost extinct	0	12.7
Cultivation of aus (Kharif-1) paddy	Increased	2.5	5.1
	Decreased	96.2	87.2
	Almost extinct	1.3	3.8
	No change	0	3.8
Cultivation of aman paddy(Kharif-2)	Increased	20.5	24.1
	Decreased	78.2	70.9
	Almost extinct	0	2.5
	No change	1.3	2.5
Cultivation of Pulses	Increased	17.7	0
	Decreased	60.8	53.2
	Almost extinct	21.5	46.8
Cultivation of oil seeds	Increased	6.3	0
	Decreased	75.9	51.9
	Almost extinct	17.7	46.8
	Not sure	0	1.3
Cultivation of wheat	Increased	0	1.3
	Decreased	20.3	28.2
	Almost extinct	78.5	70.5
	No change	1.3	0

It was, however, hoped that the theatre show would change some attitudes regarding IFM. Tables 7.4 and 7.5 suggest that it reduced previously strong local interest in fish culture in the beel (which might have adverse effects on the wild capture fishery and on access for the poor to wetland and floodplain resources), but also some people

changed opinion in favour of converting residual wetland areas to crops. Interestingly support for embankments increased somewhat but most people are still opposed to them and most respondents before and after were opposed to integrated crop-fish management.

Table 7.4 Degree of danger perceived for different floodplain practices

Practice		Pre %	Post %
1. Start intensive fish culture practices in floodplain beels	Very dangerous	.0	2.5
	Dangerous	1.3	8.9
	No danger	.0	.0
	Beneficial	27.3	69.6
	Very beneficial	71.4	19.0
2. Massive use of mosquito nets in flooded beels	Very dangerous	96.1	87.3
	Dangerous	2.6	12.7
	Not danger	.0	.0
	Beneficial	.0	.0
	Very beneficial	1.3	.0
3. Fertilizers/pesticides get in to beel water	Very dangerous	0	69.6
	Dangerous	0	27.8
	Not danger	93.5	2.5
	Beneficial	5.2	.0
	Very beneficial	1.3	0
4. Convert beels in to crop lands (raising the low lands)	Very dangerous	51.3	13.9
	Dangerous	35.5	67.1
	Not danger	2.6	7.6
	Beneficial	1.3	8.9
	Very beneficial	9.2	2.5

5. Allow indiscriminate fishing efforts (over fishing)	Very dangerous	94.7	64.1
	Dangerous	5.3	35.9
	Not danger	.0	.0
	Beneficial	.0	.0
	Very beneficial	.0	.0
6. Fishing by complete dewatering of beels in the dry season	Very dangerous	100.0	67.9
	Dangerous	.0	32.1
	Not danger	.0	.0
	Beneficial	.0	.0
	Very beneficial	.0	.0
7. Use all the beel water to irrigate crops in the dry season	Very dangerous	79.2	30.4
	Dangerous	19.5	69.6
	Not danger	1.3	.0
	Beneficial	.0	.0
	Very beneficial	.0	.0
8. Make dykes around beels	Very dangerous	0	0
	Dangerous	0	1.3
	Not danger	.0	12.8
	Beneficial	92.2	37.2
	Very beneficial	7.8	48.7
9. Taking measure for integration of crop and fish management	Very dangerous	79.2	49.4
	Dangerous	10.4	46.8
	Not danger	.0	.0
	Beneficial	9.1	2.5
	Very beneficial	1.3	1.3

t-test of difference of means pre and post, after combining strongly agree and agree,

strongly disagree and disagree:

bold indicates significant difference (p<0.05) in expected direction,

italic indicates significant difference (p<0.05) in opposite direction.

All other indicators – no significant change in scores

Table 7.5 Mean score for degree of danger from different practices.

Practice	Pre	Post
1. Start intensive fish culture practices in floodplain beels	2.3	3.0
2. Massive use of mosquito nets in flooded beels	4.0	4.1
3. Fertilizers/pesticides get in to beel water	4.0	4.2
4. Convert beels in to crop lands (raising the low lands)	4.2	4.5
5. Allow indiscriminate fishing efforts (over fishing) as it is now	4.1	4.4
6. Fishing by complete dewatering of beels in the dry season	4.0	4.3
7. Irrigate all the beel water to crops in the dry season	4.2	4.7
8. Make dykes around beels	4.1	4.4
9. Taking measure for integration of crop and fish management	2.4	2.6

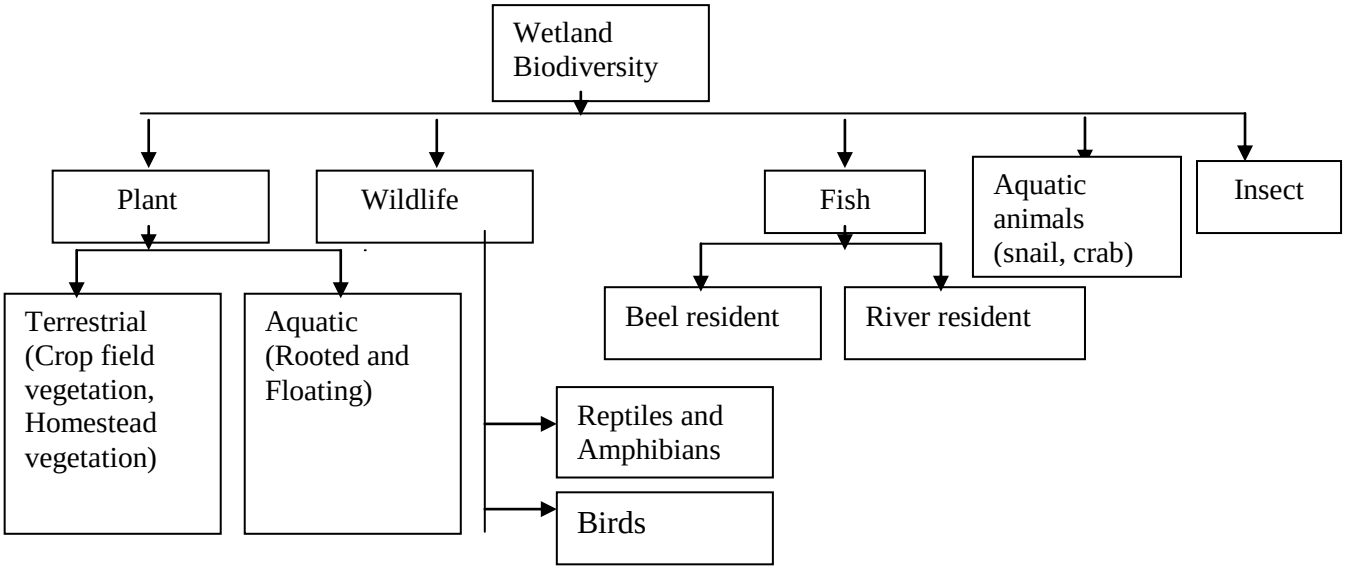
5 points awarded to most appropriate answer and 1 point less for each deviation from that

CHAPTER 8:
FISH AND BIODIVERSITY SURVEYS

Fisherman with traps, Korgar Beel

The major components of biodiversity in Korgar beel are shown in Fig 8.1a

Fig 8.1a: Major Biodiversity Components of Korgar/Hunner Beel

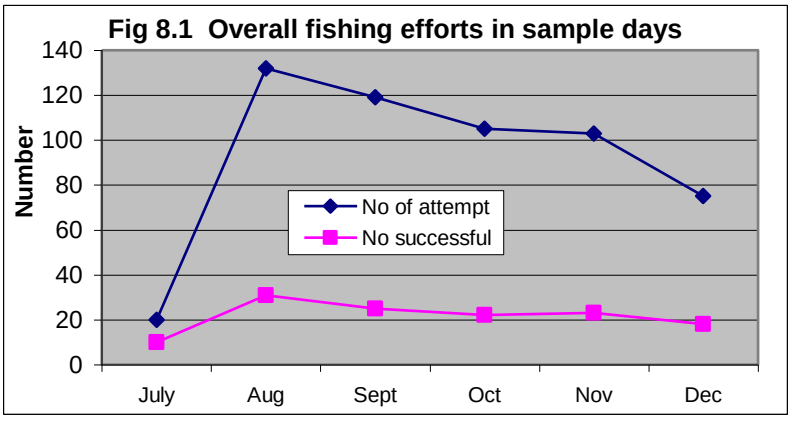


8.1 Fishing effort and gear use

Fishing effort and fish catches were recorded by a local monitor for four days in each month - two days in the first phase of the moon (full moon) and a second 2-day period was during the end of the second phase of the moon (new moon). It is believed by the fishers that the fish population and catches differ between these two phases of the moon, so the monitoring was designed to text this and to cover the variation in catches that fishers reported. One third of the fishers active on each day were monitored and their catch and the data presented here are therefore based on this 33% of the total fishers catch. Flood water starts to enter into the beel from July and remains standing up to September and then slowly starts receding. The beel dries up in December. Therefore monitoring continued from July to December – six months, and there is no fishing in the other months.

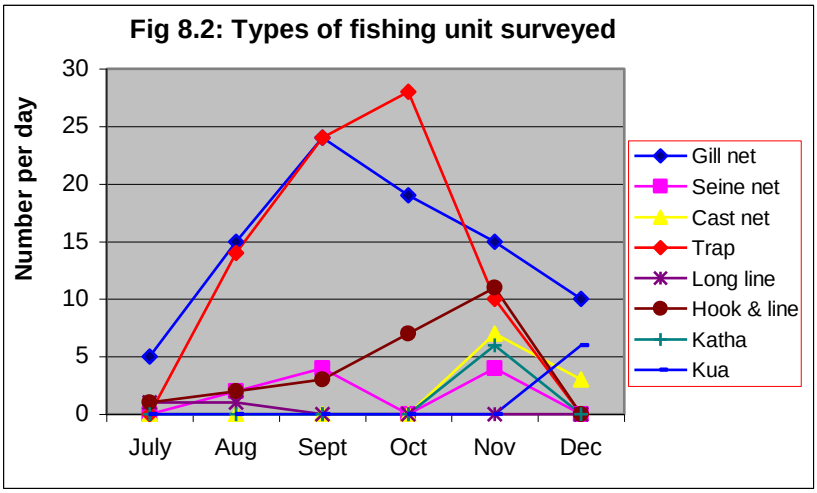
Highest fishing effort was observed in the last week of August and it gradually declined thereafter (Fig. 8.1). Water depth is high in the main period of the monsoon (August-September) and it is difficult for the fishers to catch fish when water depth increases. However, in this period people have little other work to do, so they go fishing with the hope to catch something. Fishing virtually ends when water recedes. When water levels rise water hyacinth and other debris from the river enters into the beel, and then later with the decrease in water level this water hyacinth and debris settles on the ground and at that time it is also very difficult to catch fish. In November-December people catch fish using their hand in the mud when the beel dries up. As can be seen, not all fishing efforts were successful – a high percentage of days spent fishing in the beel resulted in no catch.

Fig 8.1 Overall fishing efforts in sample days



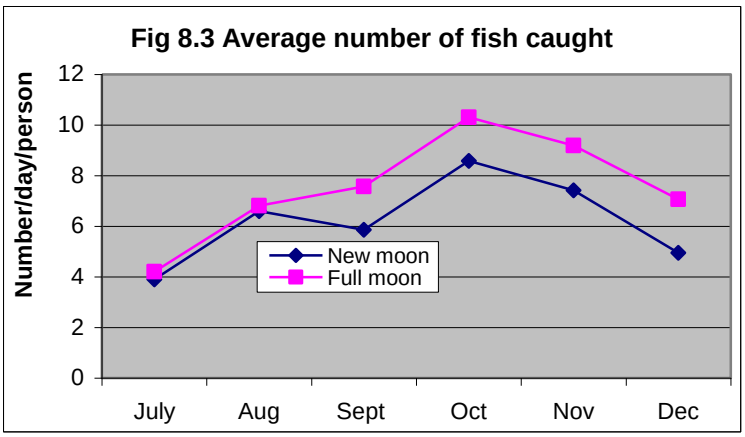
In Korgar Beel people generally fish individually using smaller gears (Fig 8.2). Traps are the most popular fishing gear used and about 31% of households own fish traps. It is easier to set traps in the type of aquatic environment found in this beel. According to the people, fish like to hide under the piles of water hyacinth and they set traps near water hyacinth piles. Although use of small mesh gill nets is officially prohibited, 15% of households still use gill nets to catch fish. However, many people in the community feel that use of current nets (nylon monofilament gill nets) should be banned from the beel. However, they think that a strong awareness campaign is needed and fishers who are using gill nets should get some loan for making other gears. One of the common fishing gears, hook and line, is not a successful gear here as hooks get tangled in the water hyacinth. Cast nets were only used when the water level was not so high. Cast nets are also used to harvest cultured fish from ponds. It is notable that 52% of households in the beel area own a pond and 54% of households own cast nets.

The “katha” is a type of fish aggregating device – a brush pile made by placing tree branches in a heap in deeper water - used as a fish shelter that provides food and a safe place for fish. When the water recedes people catch fish from katha by surrounding them with seine nets and catch all the fishes. People who make the kathas harvested them in November. The “kua” is another fish aggregating device. These are ditches where fish get trapped when the water levels fall, and after the monsoon owners of these ditches catch all the fishes by dewatering them several times.



8.2 Fish catch

The number of fish caught per person per day was different for the two phases of the moon. In the full moon period number of catch per person per day was more than catch during new moon. However, the number of fish caught by the each person per day was highest in both periods in October (Fig 8.3). In December water recedes and people fish by hand. As it was very difficult to use any gear due to thick cover of water hyacinth in the beel, people clean their field at the end of monsoon and it was easy for the people to catch fish by hand from the mud.



Not all the catch effort was successful. In a successful catch effort on an average over the two periods about one and half kilogram fish was harvested. Including unsuccessful fishing days the catch per day was lower. However, in the full moon period in each month the amount of fish caught per day was more than the per day catch in the new moon period. Although traps were most frequently used for fishing, seine nets used in September and November had relatively high catch rates.

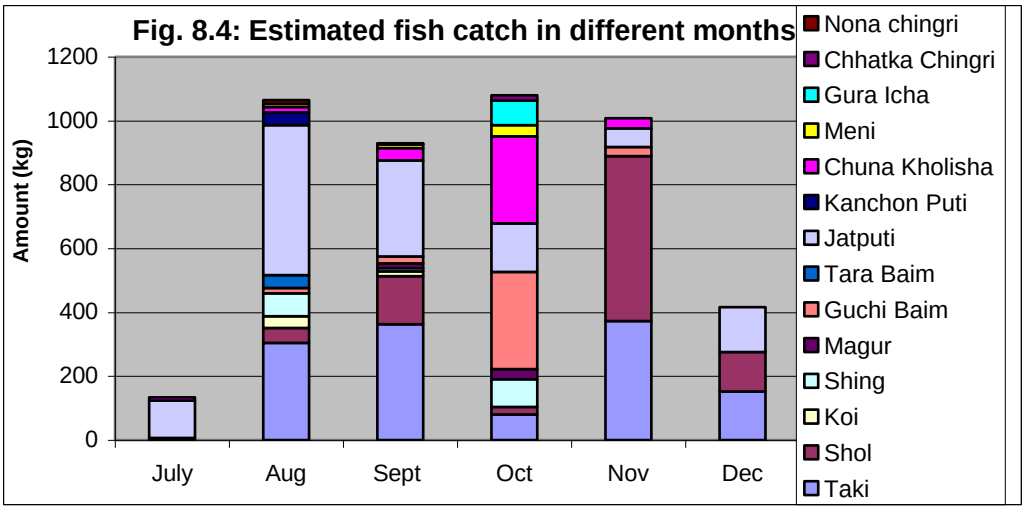
8.3 Catch composition and species diversity

One of the main objectives of the community when planning activities under the project was to restore through conservation and better management past fish populations and diversity to the beel, including species that had become scarce. However, in this first year their plans were to make people aware of the issue, to gain knowledge with other communities who have already started similar initiatives, and to plan for future actions.

The composition of the fish catch in different months varied, but only 14 different species were caught during the study period by the fishing gears sampled. When the water level was high and water entered from the adjacent river in the early-mid monsoon, the population and catch of a small fish - Jatputi (*Puntius sophore*) - was high (Fig 8.4). In November the Jatputi population decreased and snakeheads (*Channa* sp.) dominated the catch. Taki (*Channa punctata*) was caught in every month of the study period. Shol (*Channa striata*) dominated in the catch composition at the end of the flooding period. Both Taki and Shol can survive in muddy water. The climbing perch, Koi (*Annabas testudineus*), Shing (*Heteropneustes fossilis*) and Magur (*Clarius batrachus*) were occasionally caught in August-September. All three of these species have auxiliary breathing devices so that they can survive for some time out of water, and so should be suited to this floodplain beel, but their populations were very low. The community complained that Koi Shing and Magur populations have declined drastically in the beel and they have become rare species there. These species only enter into the beel with flood water as there is no initiative for their conservation in the dry season.

Other species such as the eel - Guchi Baim (*Macrognathus pancalus*) was caught every month but Tara Baim (*Macrognathus aculeatus*) was only found in August. Kanchan Puti (*Puntius corchorius*) is a rare species and Chuna Kalisa (*Trichogaster chuna*) is becoming rare, both are normally quite widespread species. According to the community once there were abundant Meni (*Nandus nandus*) in the beel, but it has declined gradually until it is almost absent. This is the only nationally threatened fish species (IUCN 2000) that was recorded in the surveys, but from our experience in similar beels in this region, Meni populations can be restored through local conservation measures.

It was surprising to observe that small shrimps – “chingri” and “icha” species (*Macrobrachium* sp.) populations are also rare in the area. Usually in seasonally flooded beels people catch small shrimps through most of the flood period. Small shrimps forming a high proportion of the catch has even been proposed as an indicator of an over fished floodplain (de Graaf et al. 2001. But in this beel the shrimp catch was very little. Once in August some saline water shrimps were caught but they did not appear any other months.



The total catch comprised of small-medium sized fishes, mostly snakeheads (Taki and Shol), followed by Jatputi. The snakeheads composed about 47% of the total catch. Jatputi stands in the second position and contributed 25% of the total catch. Chuna Kalisha and Guchi Baim each contributed about 8% of the total catch, and Shing about 4%. All the rest of the fish species composed about 5% of the total catch. It was observed that no big fish such as carp or large catfishes appeared in the beel.

8.4 Value of the fishery

The value of fish caught from Korgar Beel has been estimated for 2006 based on fish prices reported in local markets. It is estimated that fish caught in the beel during the 6-month monitoring period was about Tk 280,000 (Table 8.1). Considering that 67% of the 220 households catch fish, this suggests that the average value of fish caught per household (if they sold the entire amount) would be about Tk.1, 900 (about US$ 27 per year). Moreover the catch estimated amounts to only 20 kg/ha. These figures are extremely low in comparison to other beels in Bangladesh, and suggest that the floodplain aquatic resource system is degraded and has a great potential to be restored (healthy floodplain-beel fisheries can produce ten times this fish catch). But to achieve this there will be a considerable amount of work to for people to understand the situation of the fishery, its potentiality, and what they need to do.

Table 8.1 Estimated total value of fish caught in Korgar Beel in 2006.

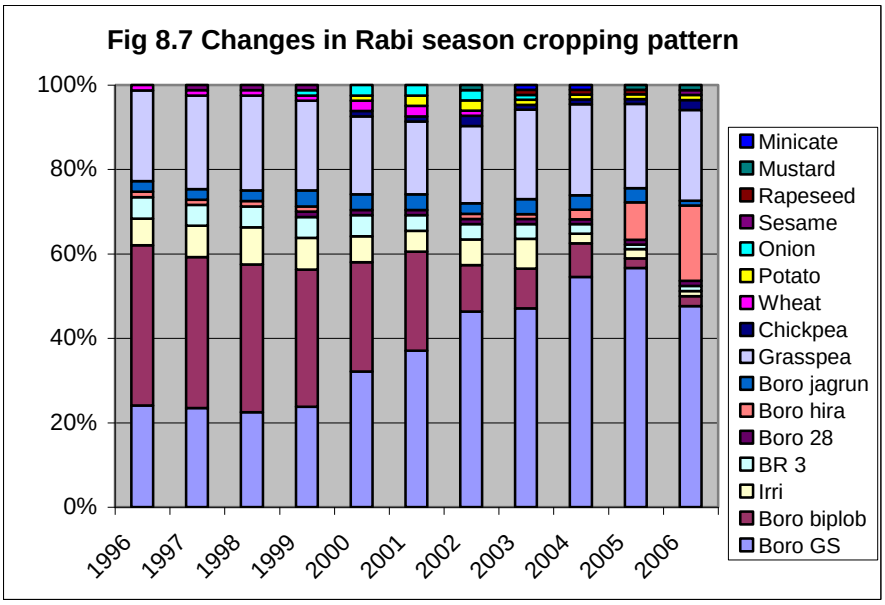
Species	Total estimated catch (kg)	Average price (Tk/kg)	Total estimated value (Tk)
Taki	1,273.1	61.4	78,232
Shol	859.8	71.8	61,737
Koi	52.2	101.0	5,270
Shing	168.6	100.2	16,895
Magur	46.0	101.1	4,650
Guchi Baim	371.4	60.3	22,385
Tara Baim	40.3	60.0	2,418
Jatputi	1,121.1	55.8	62,513
Kanchon Puti	40.3	50.0	2,015
Chuna			
Kholisha	359.8	51.4	18,488
Meni	55.4	70.5	3,906
Gura Icha	78.3	50.0	3,914
Chhatka			
Chingri	20.1	50.3	1,008
Nona Chingri	12.4	50.0	620
Total	4,498.6	63.1	284,051

8.5 Crop diversity

From the household survey it was revealed that about 95 percent of the total land in the beel was cultivated in last 10 years during dry season. About 5 percent of the land is high, 27 percent is medium high land, and about 63 percent of land is low. In the medium low lands and some medium high lands households cultivated HYV Boro paddy (varieties such as Boro GS, Hira, Boro 28, Biplob, IRRI, BR3) and in the lowest lands a small area of local Boro paddy (traditional varieties such as Minicat and Jagrun) are cultivated. In the high land and in some medium high lands other rabi crops such as mustard, rapeseed, sesame, wheat, potatoes, onion and peas were cultivated.

Harvesting grasspea, Korgar Beel

Over the years the HYV Boro paddy varieties cultivated here have changed. Farmers in the area were looking for higher and higher productive varieties. Figure 8.7 shows how one variety has replaced another variety. Boro Biplob was the dominant variety from 1996 to 1999. Since then Boro GS has dominated until 2006, but in 2006 a new variety Boro Hira has started to gain popularity. Production of Hira variety (reported to have been 9.26 tons/hectare) is higher than any other varieties that farmers cultivated here in the last 10 years. Cultivation of older “Irri” paddy variety was almost stable until 2003, but has been abandoned. Cultivation of grasspea has been more or less stable for 10 years. However, according to the farmers the variety of grasspea that they have been cultivating for years does not yield much (1.4 tons/ha). However, the crop residue is important as it is used as fodder. Farmers are eager to try new high yielding varieties of other crops such as potato, mustard, onion, garlic, etc.



During the monsoon season only in the high lands can farmers cultivate monsoon Aus paddy. These are mostly local varieties (such as Gambir, Bura and Ratul). Along with paddy now a day's farmers have started cultivating Jute here. The price of jute has increased a few folds in the last 2 years. As noted in the PAPD, this can bring problems for monsoon water quality because the jute stems and their fibres have to be retted (soaked and part rotten) in water before processing.

8.6 Other aquatic resources

Besides fish, Korgar Beel has other aquatic resources such as snails, water lily, crabs, aquatic plants, water hyacinth, grasses and aquatic fruits. Snail meat is used in shrimp farms; people eat water lily stems, crabs, aquatic fruits and aquatic plants. Water hyacinth and grasses are used as fodder. Most of the collected resources are used for own consumption. About 14 percent of these resources were sold for income. However, the actual amount earned from their sale has not been recorded. We are hoping, subject to funding, to monitor in some detail the use of other aquatic resources from this year.

A total of 31 bird species were recorded in one reconnaissance visit to this intensively used area in March 2006, of which eight are wetland dependent:

Common Kingfisher	*Alcedo atthis*
White-throated Kingfisher	*Halcyon smyrnensis*

Pied Kingfisher	*Ceryle rudis*
Green Sandpiper	*Tringa ochropus*
Asian Openbill	*Anastomus oscitans*
Little Egret	*Egretta garzetta*
Indian Pond-Heron	*Ardeola grayii*
Cinnamon Bittern	*Ixobrychus cinnamomeus*

CHAPTER 9:
LOCAL RESOURCE MANAGEMENT INITIATIVE

Already the community started to take actions collectively to improve the productivity of Korgar Beel, based on the participatory planning facilitated through this project.

Local people wanted to save their standing crops and fish from saline water, water hyacinth and flooding. The BMC and the research team worked out a temporary water control structure design. Government agencies did not come up with any help (their proposals were longer-term and a political emergency situation developed in the country during this year which from November onwards limited the scope for government agency interventions or support). The BMC decided to build a temporary embankment and a sluice gate to protect fish and crops in the area. They collected necessary support from 70 interested farming households and started to build temporary bunds and a sluice gate in February 2007. They finished bunds in the mouth of the river in May 2007 to restrain water hyacinth entrance in the area. This bund will be broken when monsoon water starts to flow strongly in the beel. The same groups of farmers hope to use their joint funds to release juvenile fish into the beel in the monsoon to enhance fish catches.

The management committee has also recently declared the internal canal within the beel as a fish sanctuary. However, materials to build brush piles for this sanctuary (which are a traditional way of improving fish habitat by providing shelter, materials on which fish food - periphytes – grow, and which discourage poaching) will have to be supplied and training on conservation is essential. The local people now know that they have to conserve fish otherwise they will lose everything. To conserve fish, rehabilitate habitat, and restore a more diverse population of fish species; the community proposed to use excess water hyacinth for compost preparation and to introduce new crops in the area. To support this, the community and project team need to find out some funds for further training, exposure visit, awareness campaign and implementation.

It was also discussed with the BMC how to restore habitat and ensure poor people's interest and benefits from the beel. The committee has decided that farmers should continue to cultivate the first monsoon crop but should not catch any fish in the area. They also agreed to try new crops during dry season with the aim of taking less water

for irrigation. They expect that if they can control water resources in the area, fish biodiversity as well as crop diversity will be greater and healthier. Moreover, they agreed that some more initiative to set up some local rules and norms, for example regarding fishing in private ditches, are needed.

If there is further support, for example from the Rufford Small Grants scheme, then the committee and local community want to have capacity building training, awareness raising events, to make exposure visits to other similar initiatives, to reintroduce from local sources some of the fish that are now absent or rare here, to start a tree plantation along the earthen bunds of the area and canal banks to stabilize soil and restore habitat, to make a small fish hatchery, and to improve habitat for fish in the canal as a fish and aquatic life sanctuary.

CHAPTER 10:
CONCLUSION

The one year project has undertaken surveys of households and fishing in the beel. It has supported one student to investigate changes in use of the beel and its biodiversity. This all shows that the area has a degraded aquatic resource base More importantly the participatory processes involved in studies and especially in planning have encouraged the community to organize and start to take collective action for improving the productivity of the beel in ways that will also restore biodiversity and are based on principles of sustainability. These plans and community activities are at an early stage but offer hope for the future.

Awareness building

Before initiation of this project and before the PAPD, local people were not aware of the importance of fish and aquatic resources and the potential gains from conservation on livelihoods of the people. There is very little scope for people to do any new income generating activities in this area. Water in the monsoon is a resource and this resource can be utilized to generate income. Exposure visits also have given them insight about biodiversity conservation. However, further training and awareness building on fish and other aquatic resources conservation and management are needed.

Capacity building

Some of the community members attended different meetings organised by the local NGO, Banchte Shekha. Three of the Beel Management Committee members received leadership training. All the BMC members received training on fishery resources management and HYV mustard. These trainings and the PAPD workshop have increased their capacity to arrange meetings, writing resolutions from meetings, and communication with local government authorities. As a result they requested some money from the local Union Parisad (local council) to build bunds. They commented that before the PAPD they were not aware whom to approach for help on development activities.

Interventions - bund building, temporary sluice gate, sanctuary

During the plenary session of the PAPD all the concerned local government officials were invited and present. The community during the PAPD workshop discussed about the possibility of building an embankment and sluice gate with the Bangladesh Water Development Board officer. He mentioned that the scheme was officially approved but it is not known when these would be built. The local people discussed in a meeting and agreed to pay for a temporary bund and a gate to stop saline water intrusion, water hyacinth and other debris entering the beel. This initiative was possible due to the PAPD and formation of the management committee.

Biodiversity conservation/rehabilitation of rare fish species

The local people wanted to culture fish when the beel will be inundated. However, they also wanted to conserve and restore biodiversity of the indigenous fish species. The price per kilogram of native fish is up to Tk. 200, depending on the species, whereas the price of carps cultivated in ponds for example is much less. The professional fishers think that they can gain out of indigenous fish conservation. However, conservation needs knowledge, practice, sanctuaries, rules and norms. The local community was briefed on the results of the monitoring presented in Chapter 8 – the fish species and amounts caught in the beel - which made the BMC think about which species they wanted to conserve and restore/produce. The project team also has to discuss with competent authorities and experts in order to give better advice on the amount and size (length) of the suitable species for stocking in this beel. Alongside this the team will find out where to get the fingerlings/fries.

It may be noted that native and exotic carps are widely cultured in ponds in Bangladesh, including in this District, but they do not reproduce. The interest of the Korgar community, and their challenge, is in how to combine part of the community investing in enhancing production with some annual stocking of carps, with also restoring productivity of native species that are able to reproduce in the beel and which can be caught by poorer people. The community is interested to try this and has started to take steps to do just this. If successful this could be an important model for Bangladesh, because in other parts of the country there is a trend for richer farmers to stock carps in floodplains at the expense of native small fish and the poor people who caught them.

New crops

Some of the crops once grown in the beel, especially local varieties of paddy have become extinct in this area. The community wanted to try those crops, if they can be collected from elsewhere to see what is the potential for those crops to be grown here in the changed environment. They also want to have some demonstration plots for potential new crops such as garlic. These will need practical training, seed, etc. The interest here is that some of the alternative crops are high value and have lower water demand in the dry season, when surface water is very scarce in this area, and some of the traditional varieties are adapted to monsoon water and have higher prices than higher yielding crops.

Timing of sluice gate operation

The community realized that if they can put install a sluice gate, it has to be operated properly so that both farmers and fishers will be benefited. Once the gate is in place they will have to form a committee to take decision on it.

Water retention

Water retention is necessary for both fish conservation and for irrigation. According to the community if they keep the internal canals full of water then the water table will remain static. In this way they will be able to minimize irrigation and can retain water for fish. The BMC will take decision on how to manage water.

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Annex-I

History and local knowledge of floodplain resources

&

Their management in Narail District

"A STUDY ON KORGAR OR HUNNER BEEL"


Submitted by

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For the partial fulfillment of BSc degree

School of Environmental Science and Management (SESM)

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Financial Support: Rufford Small Grants Programme

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T A Robin

EXECUTIVE SUMMARY

Southwestern region of Bangladesh comprises series of lake and floodplain territory. Korgar Beel of Narail district is rich in fish resources and other aquatic biological components. This vast water body plays an important role in completion of the life cycles of different species of fish. Wetland ecosystem components and historical changes are described here. This report also describe about the history of agricultural practices and fisheries. This report addresses the issues of the aquatic ecosystem, their living resources and habitat. It presents a picture of the conflicts between the retention of fish habitats and need for croplands. This research paper also represents the indigenous knowledge on the management issues. It also deals with how they minimize the environmental problems and perception about the possible solution.

CHAPTER-1

1.1 Introduction

The study of evolutionary processes of Bangladesh suggests that the existence of this nation state in the world map is a contribution of three mighty rivers-the Ganges, the Brahmaputra, and the Meghan- and their tributaries and distributaries. Most of it is located within the flood plains of these three great rivers. Large number of wet lands such as hoar, boar, beel, covers a vast portion of the total land area of Bangladesh. A series of beels are located in the southwest side of the Ganges flood plain zone. Mostly they are situated in Jessore, Narail and Khulna area.

Millions of people are directly or indirectly dependent on these natural resources. The surrounding inhabitants of this area engage themselves in primary activities such as in fishing and agricultural activities. These resourceful wetlands provide food and livelihood security for them. But these areas have shrunk due to extensive human interventions, unsustainable use and unplanned infrastructure development. The natural existing aquatic ecosystem and life support system have been negatively changing. Fish resources and all other aquatic resources have been declining due to extensive harvesting of resources along with the high population pressure. Especially fish resources have declined drastically. During the wet season in Bangladesh, inundated floodplains play a significant role in fish breeding. When farmers or flood control structures block natural waterways, the migration of fish is disrupted, reducing fish stock. The reduction in capture fisheries over the past ten to fifteen years is also due to withdrawal of water from perennial water bodies for irrigation, sedimentation of beels and pollution from agrochemicals. On the other side agricultural production and practices have also been altering. Seasonal variation in precipitation rate, channel division and salinity intrusion are now greatly influencing and changing the cropping pattern. All these problems are finally hampering the socio-economic conditions of the surrounding local people.

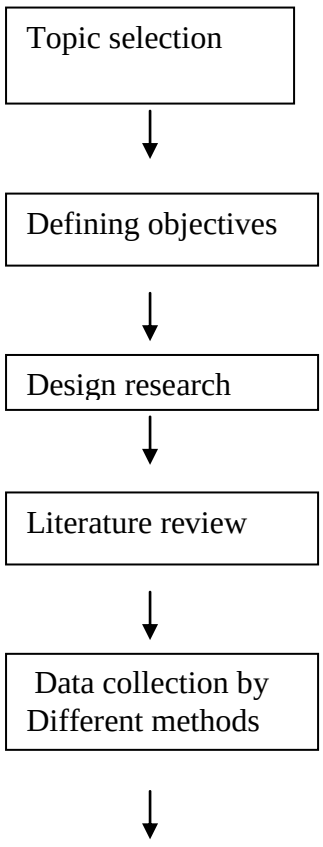
The above problematic phenomenon evince that a well-planned wetland resource management system is necessary for our country. In order to manage the water resources large number of development efforts has been taken by the Government since the year 1960. But unfortunately in retrospect of the development activities manifold aspect of social interest were being ignored by the development planners. Short-term achievements were the main goal of those projects rather than long-term achievements. Social benefits were not the principle consideration of the project designer. Lack of involvement of the local people and

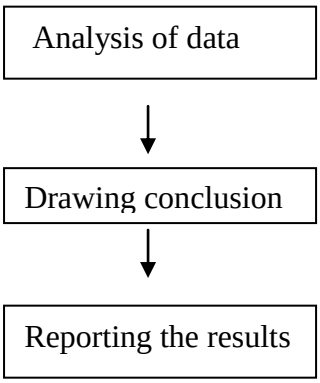
their knowledge, perception and unsustainable use of flood plain resources were negative characteristics of those management programs. Consideration of different stakeholders, coordination and exchange of information and ideas from bottom to top stakeholders was not incorporated in the development projects or programs. In assessing the project area, evaluation of the historical changing pattern in resources and land use practices are also important factors that need to taken into account by the developer so that surrounding inhabitants get most of the benefits by which they can balance the two-livelihood components-agriculture and fishery. Environmental factors need to be taken into consideration as the static bodies of floodplain support a dynamic aquatic ecosystem. Natural flow of water and migration process of fish resources need to be assessed carefully not only in term of numeric value, qualitative evaluation of the existing ecosystem and prediction of the environmental damage cost need to be assessed and incorporated in decision making process.

1.2 Objective

- To assess indigenous knowledge on the management issues of the wetland (Korgar Beel) and changes in fish resources over the historical period.

1. 3. Linear process of the expected work





1.3.1 Selection of the study area

'Afrar beel' or 'Korgar Beel' is a degraded wetland located in the northwestern part of Narail district. After the establishment of Ganges barrage and development of polder in the southern part of Khulna district some existing static water bodies in the Ganges floodplain have been facing environmental threats.

1.3.2 The following series of activities will be performed to achieve intended objective

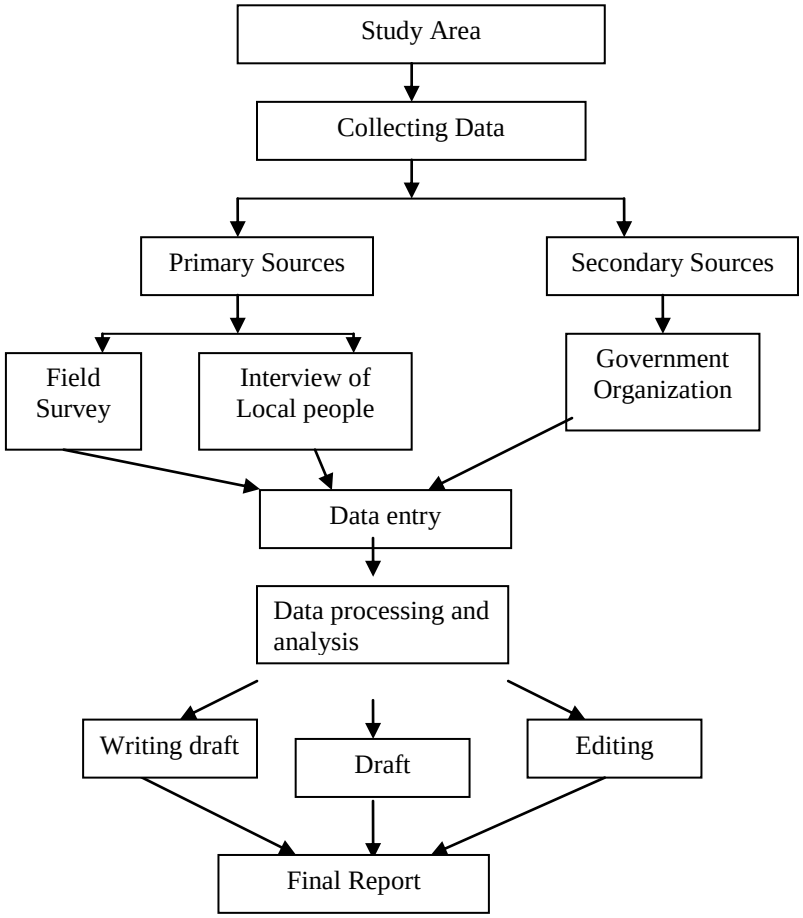
- Identification of all aquatic resources through visual observation by the local people.
- Identification of major causes (human interventions) that are inducing threats to the identified resources.
- Assessment of the conservation measures of the local community.
- Identification of the varieties of fish by assessing local market.
- Identification of different age groups of the local people.
- Consultation with focused age groups by doing semi structured interview to acquire the primary data on the historical changes of wetland and the concepts behind using different traditional management systems to cope with the capricious or gradual effects derived from any sorts of interventions.
- Identification of the causes that are deteriorating the wetland ecosystem.
- Assessment of the local people's perceptions of the future conditions of this wetland with and without any interventions.
- Determination of significant problems that are imposing constraints on the fish production system.

- Consultation with local authority and all other stakeholders about the existing water related problems and solutions.

1.3.3 Methods of data collection

a) Transect walk
b) Natural groups interviews
c) Semi-structured interviews

1.3.3.1 Data collection and entry process



1.3.3.2 Justification for using the methods

a) Among the several types of transects I will apply land use categories in my research work to get hand on experience and to identify environmental and agricultural features. This type of transect walk is highly participatory which will enhance my knowledge of the local situation and can also be used in low literacy communities.

b) Natural interviews with peasants, fisherman will help to discover problems and expectations related to the situation. The technique helps to focus participant observation activities. It also helps to establish preliminary contacts and relationship with local people. Group interaction enriches the quality of the information on the resource identification and usages.

c) Semi- structured interviews are very useful to obtain specific, quantitative and qualitative information related to a specific interest. Issues on use of natural resources can be effectively explored by this technique. It encourages two-way communication that yields in-depth opinions and perceptions.

1.4 Possible outcomes

Assessment of the historical changing pattern of wetland resources is expected to help in the development of a participatory action plan for sustainable use of wetland resources through community participation.

The assessment of fish and aquatic life will help to demonstrate a low cost development of an integrated community initiative to conserve floodplain wetland resources.

This senior project is expected to produce complete representation of the existing dynamic aquatic ecosystem, which will contribute in the efficient management of biological resources.

CHAPTER –2

2.1 Introduction

Wetlands are abundant over the landscape of Bangladesh and comprise significant number of shallow marshes and seasonal floodplain. The Ganges floodplain basin is associated with a series of marshes and depressed lands; forming a special topography and physiology of southwestern part of the country. Beels of Narail district have been providing food security and livelihood for millions of inhabitants. To some extent, this wetland helps village people in balancing two important life supporting components: fish and agriculture. They cooperate in maintaining and providing complex ecological functions of diversified ecosystem of Bangladesh.

Korgar beel is located in Mouza – Korgram, Bahirgram, Narail, Union – Mulia, Thana- Narail, District-Narail. Officially the name of the beel is Hunner Beel. Historical assessment of the settlement pattern or human geography of Korgram suggests that Hunner Beel acted as a natural resources basis that resulted in human settlement. A considerable number of resources have been provided by this wetland. In dry season this floodplain affords a base where peasants cultivate rice and other food crops. During monsoon and early monsoon period fish resources had been abundant in quantity and variety. Unlike many other natural resource bases, the ecological changes of this lotic aquatic system occurred in the last few decades due to past and ongoing development activities. Ecological changes due to environmental and anthropogenic factors are major threats for the survival of the local people. Channel division and salinity intrusion have been causing constant and cumulative deterioration of the existing environment as well as inhabitant's living quality.

After our liberation war the country was divided into more and more administrative units for better management of resources, but unfortunately incorporation of indigenous knowledge on the management issues and assessment of historical trends of aquatic resources and ecosystem in the management plan has not been yet practiced widely for better understanding and managing natural resources. As Hunner Beel is a degraded wetland, a better management and conservation initiative is urgently needed. To ensure sustainability of flood plain resources better understanding of local people's perception and knowledge about their indigenous management initiatives is important, so that large percent of benefits are shared and attained by the native people. Evaluation and assessment of all aquatic resources in terms of environmental importance need to be taken into account before starting any development activities. To predict the future status and sustainability of the

aquatic resources, assessment of changing trends of wetland resources over the historical period is needed.

2.2 Objectives

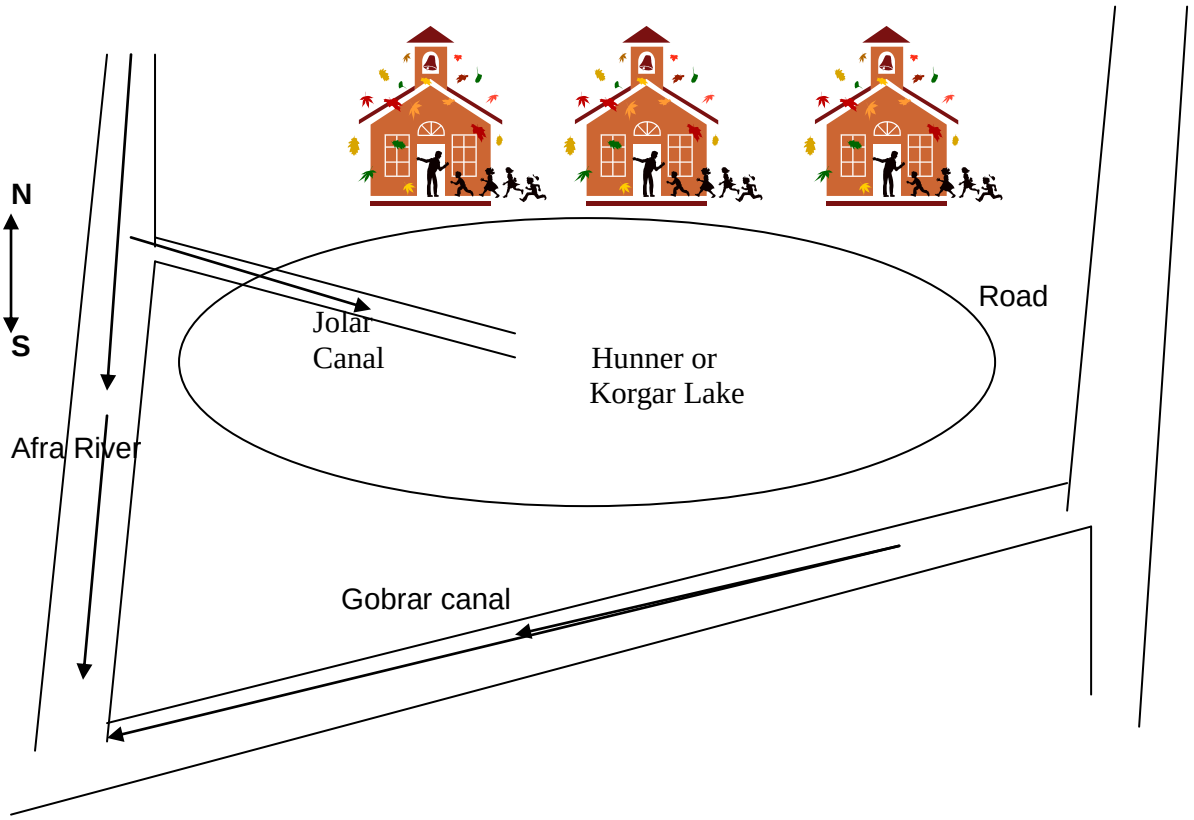
- To assess the fish resources, changes and indigenous knowledge on the management issues of the wetland (Korgar Beel) over the historical period.

2.3 Survey Findings

From different survey I have collected relevant information to accomplish my objective and research works. From the collected information I tried my best to represent results of all assessments. The output of my assessments is given below:

2.3.1 General drainage function and hydrologic features of the project area

A drainage channel (Jolar Khal) flows more or less straight through the center of the project area. Twenty years ago, one powerful local resident for the purpose of navigation constructed Jolar Khal. This canal adjoined the beel with the Kazla or Afra River that passed along the western border of the Beel. Around 10-12 small canals (tributary) have been created from the main canal. These canals carry the combined storm water and Kazla River water that is discharged into the low-lying area of the Beel. The low-lying area of the beel receives water from the upstream that is coming from the northwest along the Chitra River and Kazla is the tributary of it. It also receives brackish water from the southwest along the Bhairob River. From the River Afra another canal flows from the east along the south side of the beel with a name Gobrar Khal.



Map of the Study Area

An embankment was constructed in Magura in the year 1990. Before that huge amount of fresh water was coming from the upstream that had been discharging fertile alluvial soil into the beel area. During the field visit people complained that in rainy season water hyacinth gets into the beel area through Jolar canal and according to them it has been creating problems both for fisheries and agriculture.

Table 1: Seasonal water level (maximum, mean, minimum)

Months	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	
Seasonal depth of Beel water					3 feet	e			5fee t		1 feet		Maximum Mean Minimum

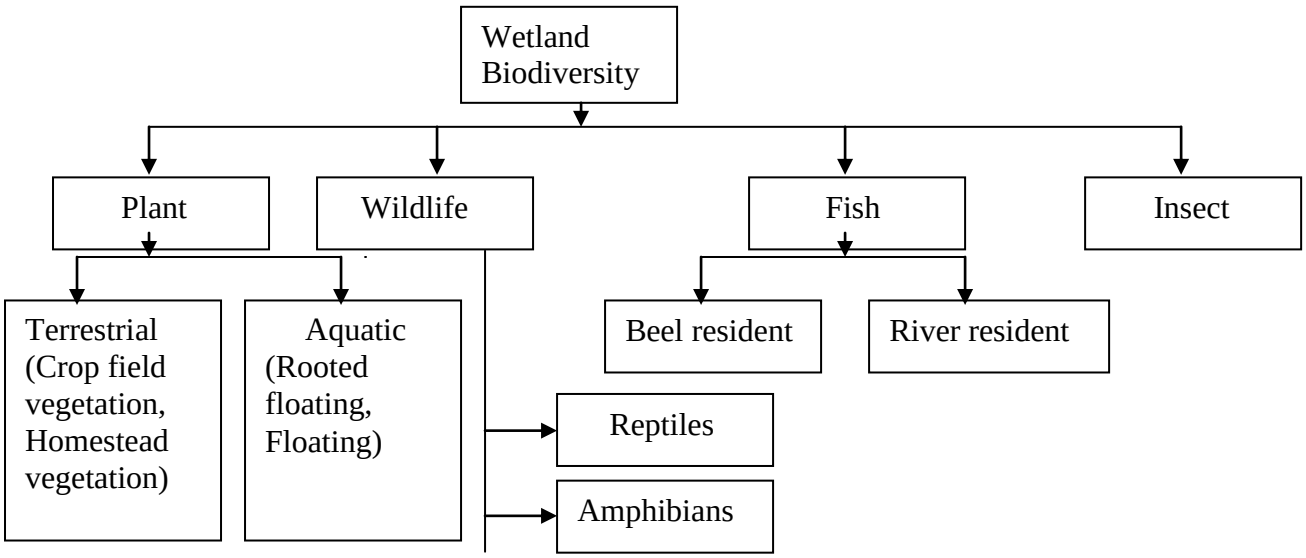
Source: Field survey

The above table indicates that from May to November water in the beel is available. During the month of August-September depth of water is maximum due to over flow of river water

and high rainfall. On the other hand, during the month of November depth of water becomes less because of less precipitation. Analysis of the seasonal water level is very important because it helps to assess the fish resources.

Picture of the River Kazla

2.3.2 Major Biodiversity Components of Hunner Beel



Picture of aquatic vegetation

2.3.3 Korgar Beel- an important resource base

Korgar Beel has a significant number of aquatic resources. Many people are directly or indirectly related / associated with the resource exploitation activities. This wetland is not only an important physical component of environment rather it executes a multidimensional socio-economic characteristic of human lives. Identified resources are:

- Fisheries
- Agricultural crop
- Aquatic plant (kolmi, shapla)
- Water bird (heron, kingfisher)

Among these agriculture and fisheries are most significant floodplain resources and have been supporting large number of people by providing livelihoods. Fisherman and agricultural farmer are two important occupations and the characteristics of professions influenced by the accessibility of floodplain resources. Fishermen capture fishes and sell these in local market. This floodplain is the major habitat of different fishes and of them Taki, Koi, Puti and Shing are dominant in terms of population. During wet season varieties of fish species use the wetland as breeding ground and landlords capture these fish for domestic as well as economic purposes. But presumably professional fishermen and subsistence fishermen capture fishes that cover almost the total area of wetland because local people construe fish as communal property. Some area of the wetland – ditches - has been privatised where

right to harvest or capture fish is in the hand of landowners. A system has been following by the cultivators to earn economic benefits from the ditches. Around 30-35 households are still absolutely dependent on the capture fisheries.

Rice cultivation is another wide spread practice that local peasants have been doing in Korgar Beel. The land area inside the beel is about 400-500 Bigha (133-167 acres; 55-69 ha). In low and medium land peasants cultivate “IRRI boro” rice (irrigated high vielding varieties). One common problem that was mentioned by the local peasants is that only one crop is produced inside the beel area in a year. In high land of the wetland the inhabitants are producing vegetables and seasonal crops.

2.3.3.1 Tangible and intangible benefits of wetland plants

- Improve ecosystem productivity (Water, nutrient,)
- Primary producer (Important component of food chain)
- Shelter for fish and habitats for wildlife
- Control soil erosion and reduce sedimentation
- Food, Fodder, Fuel wood
- Medicinal plants

This perennial aquatic system is covered with different aquatic vegetation. This is environmentally important because of its role in increasing the land fertility and also in maintaining aquatic food cycle. Planktons are primary producer that provide food for fish, which in turn provide food for water birds like kingfishers. Kolmi* is used by the local villagers to feed their domestic animals like goat. There is another important aquatic species that is snails, captured mostly by the woman and children to feed their ducks.

2.3.4 History and present context of fisheries

2.3.4.1 Past phenomena of fish species and production

Korgar beel is a breeding ground for many species of fish and helps to complete life cycle of many fish species. Koi, magur, shol, taki, puti, baila, baim, and kholisha are naturally available species in this beel. During Pakistan period it was rich in fish varieties and a huge stock of fish resources were available for all surrounding local people and met their need of protein. The quantity of captured fish was significant and almost every fisherman was able to capture sufficient amount of fish that were enough for ensuring the basic need of all. People used to catch fish by using vassal (lift net)*. According to one respondent in post liberation period, he himself and his father used to capture such an amount of fish which had a market price of around 12,000 tk (at current exchange rate US$ 176). According to another respondent who was a subsistence fisherman, fish production has declined. The degree of reduction was expressed as, in past (10 years back) he was able to capture around 200 gram fish per day but today he catches only 50 gram per fishing effort. In that time prawn was dominant and available. Business fisherman used to earn around 400-500 tk in a day by vending 1kg of prawn. During that period beel was known as 'Queet Beel' as it was source of huge amount of treasures. Fish production has drastically reduced and now a day's availability of prawn has declined. **An often-heard story**

When I was young there was plenty of fish in the beel. When I went fishing with my father we caught plenty of fish in one day.

Picture of 'Koi' fish

2.3.4.2 Changes in fishing gears

With course of time, fishing effort (number of fisherman) and catch per unit of effort (their individual catch) has also changed. During pre and post liberation period local people used to catch fish by using vassal (lift net) and push net. During my field visit I found that occasional fisherman capture fish by trapping. Practice of fishing with net* was introduced before eight years back. Number of fisherman was comparatively higher than at present but on the other hand at present number of fisherman is greater than the stock of fish resources. Catch per unit of effort was significant at present where both occasional and subsistence fisherman need to spend more time to catch a little amount of fish.

2.3.4.3 Introduction of aquaculture

Fish farming inside the beel area was introduced in the year 1997. Both white and black fish are being nurtured in that pond. During the spawning season some fish with the usual flow of beel water enter into the pond or "Gher". As the fish stock in the beel is declining moreover, for the low water levels the pond cultivator had to stock juveniles of Carp, Prawn, and Katla*in his pond in the last year. According to him, this is a very good way for continuous supply of fish yield.

Table 2: Major changes in fish resources and beel water system in between different important time period

Year	Important changes and activities	Associated environmental impacts
1960-1971	Abundant fish species (white and black fish) and high fish production, flood protection activities in the up & down stream Area (late 1960s), fish farming in 'Kua' started, snails and water lily were abundant	Beel were repository of fish treasure, Kagla river pull Hilsha, Rui, Katla in the Beel, channel division
1972-1988	Flash flood occurred, 1988 major flood	River fish were available (Hilsha), big shrimp were abundant
1987-1998	Establishment of embankments in Magura (1991), introduction of	Salinity intrusion started (1996), low water flow from upstream &

	aquaculture or Gher (1997)that brought in Carp species, canal was made inside the beel area	beel water level decrease causes less discharge of sediment, big shrimp were available
1999-2006	Tidal inundation through Bhairob river, less local precipitation, changes in water use (for cooking, washing, kitchen material), snails population is very negligible	Beel bed is increasing, salinity in beel water is increasing, water level is falling down

Source: Field Survey

The above table contains major changes in fisheries, aquatic ecosystem, beel water drainage functions over the historical period. The interpretations of the above table also facilitate in identifying the deteriorating trends in the wetland environment. It was rich in fish resources but several unplanned infrastructure developments lead to negative environmental repercussions that have relinquished all hope and effort to exploit valuable aquatic treasures.

Table 3: Identified causes of fish reduction by different stakeholder groups

Natural groups	Reasons
Peasant	Saline water damage larvae & juveniles, number of water hyacinth is beyond tolerable level
Subsistence fisherman	Less precipitation, population pressure increase, over exploitation in breeding period
Business fisherman	Less water availability in breeding season, agro-chemical runoff from agricultural land, washing of jute fiber pollutes water, channel division
Woman working in the homestead area	Salinity intrusion, water hyacinth

Source: Field Survey

2.3.5 History and present context of Agriculture

Sixty years ago peasants of Korgram were self sufficient in agricultural production. In those times, they were traditionally experienced in coexisting with seasonal variations, and had been cultivating rice and other seasonal crops in and around the

periphery of the beel area in conformance with seasonal cropping calendar. There was a wide range of opportunities for production rather than limitations on agricultural production. Many crops were able to achieve their full yield potential under Korgram's suitable ecological conditions. In Pakistan period people used to cultivate "Kalo Boro" in the month of Kartik-Agrayhan. For the present day this is just a history.

In post liberation period, practice of IRRI cultivation in Rabi season was introduced and since then it has been very popular among the peasants with a local name "Block Rice". Watermelon and Teel* (oilseed) had been cultivating by the local residents during pre and post liberation period. Twenty years ago low land of the Beel area was suitable for Teel cultivation and farmer used to cultivate in dry season. Sugarcane and jute agriculture in the beel were abundant in Pakistan period. 30 years ago, local residents surrounding the beel area were cultivating Koloi and Kheshari. In that period for irrigation purpose peasants used water of Kazla River. In the year 1997 local people started using STW (Shallow Tube Well) to irrigate their agricultural land as the concentration of salinity has been increasing in river water.

The local people are still cultivating sugarcane and jute in surrounding/high land of the beel area. Talking about the present condition of rice production, excepting Block rice, in the pre Kharif and Kharif periods or seasons the beel land area is left as fallow land.

Table 4: Crops cultivated in different land type

Land type	Land area (Bigha)	Crop
Low land	300	IRRI, BORO
Medium land	100	IRRI, BORO
High land	50	Vegetable, Rabi
Fallow land	50	

Sources: Field Survey

Peasants are working in agricultural land

At present the hybrid rice varieties (BR-11) are planted in the month of August and harvested in the month of December. This is being cultivated on the high land. From different respondent I found out that hybrid rice produce around 40 maunds in a land area of 48 decimal (equivalent to about 8.2 t/ha) but the yield potential completely depends upon the level of beel water. In low land of the beel, irrigation is not essential but in high land of the surrounding area irrigation is required. In the process of rice cultivation in low land fertilizer is less required. Urea is less required than potash in the process of rice cultivation. Production cost associated with rice cultivation is high at present as a large labor force is required to clear water hyacinth. In other words to irrigate a land area of 48 decimal with a shallow tubewell 1400-1500 Tk is necessary. In the same amount of land 25 kg of fertilizers and 1 kg of pesticide are needed to produce paddy like GS, Shorna, Hira and the market price of 40 kg (1 maund) of rice is 360-390 Tk.

In homestead area women cultivate puishak and datashak * (leafy vegetables) and other seasonal vegetables. Mahogany, palm and banana are among the abundant tree species in homestead plantation area.

2.3.6 Indigenous knowledge of the local community on wetland management issues

Both fisheries and agriculture have been facing several environmental threats and of them salinity intrusion and increase in water hyacinth population have emerged from

unplanned FCD and FCDI project establishment in the upstream as well as downstream area. Rice production in Kharif season has become problematic in this area. People started taking initiative to confront these threats. Ten years ago, to prevent salinity intrusions so as to protect losses in rice production local community started constructing dam with earth and bamboo. But local people have not taken any further initiatives for last two years. Some landowners (rich peasant) have raised their cultivable land and have been cultivating rice in two seasons. On the questions of management of both fisheries and agriculture simultaneously, some local people adopt knowledge to cope with certain types of environmental problems. In dry season they produce rice and in monsoon period they leave their lands as nursing ground of fish resources. During my field visit I gathered some information on this 'Hapa' or 'Kua' system. Owners of these 'Hapa' harvest fish in the month of November and earn around 5000 tk in each year. They usually prepare the 'Kua' to make suitable habitat for fish in the months of August and September. After November they prepare their land for dry season rice cultivation. During my field visit, I discovered that people are all demanding for a sluice gate. Looking at the present environmental problems government (Bangladesh Water Development Board) has a proposal to construct an embankment and a sluice gate to regulate the water flow into the beel according to local people's needs. However, it is not certain if this will go ahead.

2.4 Analysis of the findings

2.4.1 Seasonal flooding and fish production

Understanding of hydrological features is essential to describe the general characteristics of inland fisheries of Hunner Beel. As broadly speaking in Bangladesh extensive seasonal flooding by high water levels during the monsoon generally occurs between July and November. This flooding has a high variation in terms of timing, duration and intensity as it depends on the monsoon rainfall. In contrast to the abundance of water in the monsoon, water areas decline rapidly during the dry season (December-April), which is characterized by very low rainfall and high evaporation rates. This contraction and expansion of aquatic habitat greatly influences fisheries production. Fish and prawn populations in Hunner Beel are adapted to these variations, and their life cycles are tuned to it. Breeding and growth are strongly related to the sequence of flooding. Larvae, juveniles and adults grow in nutrient rich floodplain areas during monsoon, after which they migrate back to river Kagla and depressions in the beel at the end of the monsoon. They become

concentrated in channels and the beel in this period and are more vulnerable to fishing activities.

Black fish species on the basis of their migration and reproduction behavior are mainly omnivorous/carnivorous bottom dwellers; they reproduce at the onset of the pre-monsoon as the water level in the beel starts rising due to the congestion of rainwater. At the end of the rainy season the young of the year and adults migrate back to, or get trapped in, the low-lying beel areas, where they can survive the harsh conditions of these small permanent water bodies during the dry season. They are adapted to resist low dissolved oxygen concentration and high water temperatures. The main adaptation is their auxiliary respiratory organ used for the uptake of atmospheric oxygen. That is why; black fish species like Anabantidae (Koi, Kholisha), Ophiocephalidea (Taki, Shol) and Clariidea (Magur) are still available here.

2.4.2 Unsustainable fishing practice

Looking at the trends of fishing in the beel area it is quite clear that dependency on fish resources of the local residents is gradually declining. A very negligible percentage of residents are still somehow linked with fishing. Many people mentioned that harvesting of fish during breeding season was one of the major reasons for the continuous depletion or decline of fish production. Over fishing in the adjoining area of canals and beels affects the natural migration of fish, which finally results in less fish production. In addition to this, over fishing by the occasional and subsistence fishermen to meet the increasing demand for protein and daily needs is also depleting fish stock.

In the last period of 17th century Thomas Robert Malthus in his essay on 'the Principle of Population' stated that the increase in the food supply could not keep up with population growth. His argument was true in a sense that talking about supply or availability of fish to local consumer and local business fisherman has been largely declining due to high multiplication of hands in capturing fish and growing demand.

On the other hand, the maximization of profit from a natural capital, within a very short period finally leads to several environmental disasters. To make it clearer, we can say that, aquaculture in a beel area sets a strain upon the natural wetland ecosystem by introducing the invasive fish species that are replacing the local beel residents. Uses of insecticides in this 'Gher' to grow fast growing fish species

ultimately contaminate the Beel water. In other words, it hampers the natural life cycle of Black fishes.

2.4.3 Changes in land use pattern

From survey findings it is revealed that land use pattern transformation has occurred in and around the wetland. Agricultural crop production and fishing were the predominant economic activities of the local inhabitants of Korgram. Natural environmental conditions of the wetland used to support two major components of the livelihood (fisheries and agriculture) and were enough to provide adequate yield. After the assessment of fish resources and both commercial and subsistence crop production processes it seems that agricultural practice on this wetland are getting more priority than that of fishing. From my point of view, this is actually happening only because agricultural yields are being destroyed by the salinity intrusion through water in several canals. In other words, landownership system is private and the threat to agricultural production mostly oriented farmers with self-interests to how can they cope and maintain production. On the other hand to some local people fishing is also getting enough priority because they have little land inside the beel area. These people are very much concerned about fish production and availability of water during the breeding season of fish species. The use of beel area is now altering as cropping intensity is very low in the low land of the beel and also the probability of total yield in high and medium land type is mostly controlled by the inundation level of saline water. If we observe the activities on this wetland for one year then the working calendar would be like that in Table 5.

Table 5: Working calendar of a year

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Activity	Agricultural activity					Fishing						

Source: field survey

Agricultural activities finishes

Fishing starts

2.5 Recommendation

1. Before taking any initiative government should take lesson from past experiences.
2. To reduce salinity intrusion sluice gate can be an effective solution but local people or government should monitor the clearance and maintenance of the sluice gate.
3. Any further development work should take into account the fish migration and production system and need to construct fish passage to sustain and enhance the quality of fish resources.
4. Refrain local people from fish capture in pre-monsoon period to create better opportunity and habitat for fish breeding.
5. Widespread adoption of improved Rabi crop varieties can reduce the deficiency in agricultural production.
6. 'Hapa' or 'Kua' system that local people are practicing to manage production efficiently of both agricultural crops and fish can be a good management tool for the sustainable exploitation of aquatic resources.

2.6 Conclusion

Historical analysis of aquatic resources of the Korgar Beel suggests that the overall quality of wetland biodiversity and ecosystem is deteriorating. The saline water accumulation in beel area is continuously increasing the threats to rice production as well as fish production. Surface water level is declining due to large amount of sediment discharged by the river Kazla which continuously decreasing water holding capacity of the wetland. Local perception and need assessment determine that possible solution of these management and environmental problems is 'sluice gate'. But as a student of environmental science I must recommend that extensive hydrological assessment is required before taking any decision for further development initiatives.

2.7 References

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