

**IMPACT OF COMMUNITY MANAGEMENT ON
TWO BEEL FISHERIES IN BANGLADESH**

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Declaration

This dissertation is original and
has not been submitted either partly
or fully for the award of any degree in
any university at home and abroad


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CERTIFICATE

It is the pleasure to certify that the entire work incorporated in this dissertation has been conducted by Ms. Anwara Begum, under our guidance and supervision. We forward her dissertation entitled IMPACT OF COMMUNITY MANAGEMENT ON TWO BEEL FISHERIES IN BANGLADESH being submitted for the examination of Ph. D. degree in the Faculty of Biological Sciences, University of Dhaka, Dhaka. We recommend that Ms. Begum has fulfilled all requirements in terms of scope, quality and presentation embodied in the dissertation in accordance to the rules of this University.



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Dedication

**Dedicated to the fisher community
of Bangladesh who has been struggling
to get access right in the fisheries resources.**

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I recall with great pleasure and gratitude to the people, especially the fisher community of Hamil Beel and Rajdhala beel, whose resoluteness inspired me to undertake this study. Having worked in CBFM project, I had the rare opportunity to witness their firmness for making a change, which makes me proud to be a compatriot in their enduring journey.

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Abstract

This research explored the impacts of community-based management on Hamil and Rajdhala beel fisheries in Bangladesh during the period of May 1998 to April 2000. The study necessitated to extensively deal with the complexities of gaining access right and management of the waterbodies by the community. The study also observed the influence and effect of the initiatives in the livelihood practices of the community. The basic feature of conducting this study was the involvement and participation of the user community especially in areas of social mobilization and resource management.

It was observed that organizing the community in the process was the most crucial part and by successfully bringing them in the threshold of the initiative the subsequent tasks *i.e.*, capacity building, resource management and institution building have become conducive. With enhanced capacity the community was able to establish their right in the resource and at the same time supplemented their financial and technical capabilities.

The beels were under traditional culture system where CBFM initiated some norms appropriate for beel fisheries. Maximum yield was 793.6 kg/ha/year, which has not been possible before the introduction of CBFM approach. Per capita income of the user members rose to Tk. 4,229 and an equitable distribution system has been established. Significant increase in the total income was also recorded as they have also embarked upon various income generation activities.

Water quality and primary productivity were in favor of natural environment needed for fisheries enhancement and in most cases their interrelationships were found statistically significant ($P < 0.01$). It was noted that due to continued stocking, production of non-stocked indigenous fish declined. The study found that where the community had access over the resource with affordable lease fee, the possibility of installing better management practice by the community institution was easier. This was evident in case of Hamil beel but where such conditions were absent it was a difficult proposition. The latter conditions attributes to Rajdhala beel.

The findings of this study could be a basis for drawing some policy implications on long-term access right, cost, and community friendly legislation. Addressing these preconditions is essential in giving community-based management effort a sustainable option. In depth research in the field of different features of the water bodies would be essential to be able to make the community more efficient in resource management.

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GLOSSARY

Beels	A small lake/low-laying depression/a permanent Water body in a floodplain or a water body created by rain or floodwater.
Bhat	Rice
Development Allies	Enlightened members of the community who have a passion for social work and stand behind the cause of the poor segment of the community. They represent various sections of the civil society.
Fishpass	Fish friendly water regulatory structure
Floodplains	Land inundated with rainwater congestion and river flooding especially during monsoon.
Beel Management Committee	Representatives from primary groups converged in (BMC) an organization to cater to the interest of the ordinary members (composed of 20-30 members).
Haor	Large depression between two or more rivers. The depression is generally a bowl shaped, deeply flooded permanent freshwater wetland. Each haor consists of one or more beels. It functions as a small internal drainage basin.
Jag/katha/katha fishery	Branches of trees submerged into deep water for fish habitat for a certain period.
Jalmohals/Sairatmohals	Public waterbody under the ownership of Ministry of Land.
Jele/dhibor/koiborto/das	Refers to all fishers and boatmen regardless of caste group and mostly fishermen by birth.
Matshyajibi	Fishermen by profession

Jheels/Pats	Closed waterbody related to lake.
Khas	Public property
Khal	Canal
Machh	Bengali word meaning fish
Thana/Upazilla	Sub-district.
Zamindar	Feudal lord, holding vast amount of land property and collects revenue from the inhabitants.

ACRONYMS

AC	Assistant Commissioner
ADB	Asian Development Bank
ADC	Additional Deputy Commissioner
BARC	Bangladesh Agricultural Research Council
BRAC	Bangladesh Rural Advancement Committee
BCAS	Bangladesh Center for Advanced Studies
BARICK	Bangladesh Resource Center for Indigenous Knowledge
BMC	Beel Management Committee
BS KB	Basukhali-Salimpur-Kola-Barnal
CBFM	Community Based Fisheries Management
CBRM	Community Based Resources Management
CIFRI	Central Inland Capture Fisheries Research Institute
CPR	Common Property Resources
DC	Deputy Commissioner
DEEDS	Development Extension Education Services
DFO	District Fisheries Officer
DoF	Department of Fisheries
EUS	Epizootic Ulcerative Syndrome
EMAP	Environment Management Action Plan
FAO	Food and Agriculture Organization
FAP	Flood Action Plan
FCD	Flood Control and Drainage
FGD	Focus Group Discussion
FIVDB	Friends In Village Development Bangladesh
FRI	Fisheries Research Institute
GDP	Gross Domestic Product
GO-NGO	Government Organization and Non Governmental Organization
GoB	Government of Bangladesh
ICLARM	International Center for Living Aquatic Resources Management
IFAD	International Fund for Agriculture Development
IUCN	International Union for Conservation of Nature
IGP	Income Generating Project
IMOF	Improved Management of Open Water Fisheries
KAS	Knowledge Attitude and Skill
LGED	Local Government Engineering Department
MoFL	Ministry of Fisheries and Livestock
MoL	Ministry of Land

MOU	Memorandum of Understanding
MPO	Master Plan Organization
NERP	North East Regional Project
NFMP	New Fisheries Management Policy
NGO	Non-Governmental Organization
ODA	Overseas Development Administration
OLP	Oxbow Lakes Project
PDLG	Participatory Development Learning Group
PG	Pituitary Gland
PRA	Participatory Rural Appraisal
RDP	Rural Development Project
SIS	Small Indigenous Species
SRC	Self Recruiting Species
TFP	Third Fisheries Project
TNO	Thana Nirbahi Officer
UNDP	United Nations Development Program
UZP	Upazilla Parishad
WDB	Water Development Board

CHAPTER 1

INTRODUCTION

Bangladesh has extensive wetlands that form an important fisheries resource. Thousands of poor and fishers are dependent on these wetlands for their livelihood. Almost all the entire country can be considered as a vast network of wetlands, which include river, lakes, floodplains, ponds, beels and even seasonally flooded agricultural lands. The beels are biologically important habitats as they play a vital role in the recruitment of fish populations in the riverine ecosystems and provide nurturing grounds for commercially important fishes. The beels vary widely in size, shape, extent of riverine connection and offer tremendous scope for expanding both capture and culture fisheries. In addition to having very important natural ecosystem functions, and important habitats in their own right, the wetlands of Bangladesh also happen to constitute important fisheries that provide a major source of protein and micro nutrients in the diet of the people, particularly the poor, as well as generate employment for a large number of people.

In the form of permanent and seasonal, there are 4,498 beels in Bangladesh comprising an area of 114,161 hectares (DoF, 2001). There are many beels that have similarities with big ponds, but the production is lower than that of the ponds. Per hectare production from pond is 2,550 kg, while it is 653 kg in case of beel fisheries (DoF, 2001). There are number of factors that is responsible for the low yield, in spite of potentiality of the beels. The following are some of the major reasons behind the low yield.

- Beels are used as capture ground,
- Limited initiative for production enhancement and conservation measures.
- Modification of the beel habitat,
- Management options had limited scope for community involvement,
- Inadequate user-friendly policies.

In Bangladesh, most of the inland open-water fisheries exploitation activities are small-scale and traditional. Over the years these fisheries have retained an open-access characteristics in the absence of a consistent and effective management policy (Ahmed, 1989). From the management point of view the beels, both in terms of technical as well as social would be considered as important issues to increase the production of beels, restoration of bio-diversity and habitat through a sustainable management system ensuring a better livelihood of user community.

Nearly 8% of the population of the country is estimated to be dependent on the fisheries sector for their livelihood (ODA, 1996). But for a long period of time management system of most inland fisheries have led to a mode of production characterized by total

dependency of fishers on the middlemen and major share of benefits are being enjoyed by those who contribute least for the development of the sector. In addition, the depletion of the water bodies due to erosion, siltation, drying up of natural wetlands exacerbated the process of declining fisheries resources of the country.

In view of the priority on poverty reduction, especially of the fisher community, it is time to ensure their access to fisheries resources not only for the improvement of their livelihood but also for augmenting the resource. Bangladesh's major resource is its people. Rather than making these people part of the problem, it is time to see them a part of the solution. Involving people and empowering them to assume an active role in resource management in partnership with the Government and other development actors is a critical step towards a more sustainable and human development path (Sugunan, 1995). There is every prerequisite to meet the conditions to increase beel fisheries production significantly involving fisher community which should be an important approach for sustainable management of beel fisheries in Bangladesh. Therefore, it is not an option but an imperative to look discreetly into the management dynamics of beel fisheries both in terms of biological and social aspect.

Since the British colonial period several policies were adopted as management tools for inland open water fisheries including the beels. Nonetheless, any of the options did not fully prove to be a success and sustained. At the present time, and common with other country a new concept namely, Community Based Fisheries Management (CBFM) has been initiated on experimental basis for improvement and management of inland open-water fisheries (Sugunan, 1997). Department of Fisheries (DoF) initiated this approach highlighting the relationship between fisher communities with fisheries resources in an integrated system ultimately developing sustainable fisheries management based on scientific norms. This proposition forms the basic concept of CBFM project. This concept of inland open-water fisheries management in Bangladesh would be an area of interest and it would be seen by way of implementation of the project measures whether improvements can be achieved over the prevailing system.

1.1 Beel fisheries management practice

Traditionally the availability of fish in beels comes mainly from natural sources. They are reared in the natural water bodies such as rivers, floodplains, canals etc. During monsoon these fishes flow to the floodplains, beels and grow up and at the same time meet certain requirements of fish intake and livelihood of fishers. One important feature of beel management was to lease these beels to the highest bidder through public auction. The qualified bidder would then resort to sublease, secondary lease, tertiary lease to the local fishers and or to neighboring fishing community. The lease value started to go up and the

leaseholder use everything at his disposal (use of gears, crafts, indiscriminate irrigation), neglecting all norms of safeguarding the resource in want of maximizing the profit. Subsequently, the biodiversity of the resource would have had serious affect and at the same time those who largely depend on the beels, would not derive any benefit out of these leasing systems. To comprehend the system better, it may be looked into the historical perspective of the leasing systems.

Beel Fisheries in Bangladesh presents several characteristics in the concept of its management systems. For long, the fisheries of beels have been exploited as an open-access captures fisheries. Generally, the beels are public waterbodies and fall under the responsibility of the Ministry of Land (GoB, 1987). Some beels, especially those within the reserve forest belong to the Department of Forest, while some beels subjected to irrigation control are administered by the Water Development Board (Rahman, 1989). In the past some closed beels belonged to the *Zamindars* (feudal lords). Thus management of beel fisheries has become the responsibility of several government agencies and ministries since the British rule, and subsequently by several government acts during the Pakistan period (Aguero, 1989). Due to multiple participation of agencies, management of beels makes a complex system. This has led to unclear delimitation of responsibilities and management priorities resulted in distorting practices for allocation of fishing rights, collection of revenue, and surveillance of fishing activities. Under the prevailing system, fishing rights were given through periodic leasing to highest bidder through open auction. In the system, priority was given to the fishermen cooperatives with the intention of increasing the participation of more disadvantaged fishermen (Rahman, 1989). Due to lack of leadership and financial resources to compete in the bidding process with the intermediaries, successful bidders in public auction often turns out to be white-collared middlemen. The middlemen then establish an extensive network of sub-lessees. Fishers in need of fishing grounds is required to pay these sub-leasing chain members to obtain fishing access. The experience of traditional management methods through periodic leasing to middlemen have produced an adverse effect on the sustainability of resource, and most significantly a worsening impact on the economic conditions of the thousands of traditional fishermen engaged in the fisheries, over the years (Ahmed, 1989).

In government owned fisheries, the leasing generated many controversies that often ended up in tug of war in carrying out administrative responsibilities among government agencies. In resolving the inter-ministerial disputes relating to the *Jalmohals* (haors, baors, beels etc.) transfer of their management gave rise to an initial legal complication. Therefore, in 1980, the management of government owned water bodies was handed over to the Ministry of Fisheries and Livestock (MoFL). But that initiative was not fully successful. Ultimately in 1983, the management was reverted to Ministry of Land (MoL). Again in 1984, the management of public water bodies within 7 to 49 ha was given to the

newly created Upazilla Parishad (UZP) for revenue generation. The UZP has failed to maximize revenues owing to nepotism in leasing and other administrative bottlenecks (Siddiqui, 1989). But in 1987, water bodies within areas less than 3 acres declared as open to public access and held under the local officials of the MoL. This act of dragging forcibly the management rights of water bodies among the agencies created various problems against production enhancement, revenue maximization, social integration, etc.

The Government of Bangladesh has taken note of all problems relating to leasing systems. In 1986, the GoB introduced the New Fisheries Management Policy (NFMP) to eliminate the middlemen interruptions in the existing leasing system (Siddiqui, 1989). The salient features of the NFMP were to:

- establish rights of the community,
- eliminate the middlemen from the *Jalmohals*,
- maintain and improve the productivity of the open-water fisheries on sustainable basis.

The NFMP aimed at increasing productivity and sustainability of fisheries and rehabilitation of common property fishery resources (Rahman, 1989). Initially these new experimental policies were initiated in 10 different *Jalmohals* in 1986 and in subsequent year 150 *Jalmohals* were brought under the policy (GoB, 1987). For proper implementation of the NFMP, a national coordination committee was formed taking representatives from the concerned agencies. However, before giving the NFMP a modest start, inter-ministerial conflict over rights of the management resulted in the reformulation of the management systems through reorganization of the committees at different levels. The NFMP though started to establish the rights of fisher community could hardly fulfill its objectives as middlemen in this case were so active in taking the possession of the *Jalmohals* and as a result, establishment of the rights of genuine fishers in the particular beel remained a distant dream. Attempts were made to stock fingerlings in the floodplain under Improved Management of Open Water Fisheries (IMOF). But there was hardly any effort to look after the management of the stocked fingerlings as well as participation of the local fisher community in the project. The result therefore was far from satisfactory.

During the implementation of NFMP by DoF, the overseas donor Ford Foundation with collaboration of the International Centre for Living Aquatic Resources Management (ICLARM) provided technical and financial support. This collaborative initiative gave a momentum towards the productivity, sustainability and distribution of benefits. However, in late 1995, again an action research program namely Community Based Fisheries Management (CBFM) have been launched to try and assess alternative models of collaboration involving government, non-government agencies and fisher community. The

program was designed to achieve a greater efficiency, equity and sustainability of open water and beel fisheries resources by its surrounding community. The activities were more specific towards:

- Developing the community for managing the resources,
- Supporting the community through creating and providing alternative employment and income generating activities during lean season,
- Providing literacy courses and
- Disseminating policy relevant information to the user community.

The major thrust of the project was sustainable fisheries management practices. Therefore, the issues of sustainable exploitation of fish resources, protecting natural environment, reduced pressure on stock, etc. were also considered. The objectives of partnership development among GO-NGO-Fishers are to (a) facilitate the community in utilizing resources more equitably and (b) to develop their capability for sustainable management practice through local institutions. Figure 1.1 indicates the general model of the project activities and relationship among partners, although the details differ in application between waterbodies, NGOs and communities.

The role of Government is to give the rights of the waterbodies to the fisher community through mechanism of handing over within the government system. The MoL transferred the waterbodies to MoFL for management of fishing communities for three years, with a condition that the fishers pay the government 25% higher taxes on in the first year than that of the previous year. The DoF was responsible for handing over the user rights to the fishers through a Memorandum of Understanding (MoU) with the NGOs.

The DoF was the responsible for overall coordination of the activities. The NGOs have prime responsibilities for assisting fisher communities to strengthen their organizations and to develop additional income sources. The ICLARM is responsible, in collaboration with DoF and participating NGOs developing research protocols and research implementation, institutional strengthening. The donor, Ford Foundation has provided funds to each of the partner organization. Thus, the CBFM, which is common in other countries, fulfilled the requisite of technical and social aspects of the management of open water fisheries in general, beel fisheries in particular (Pomeroy and Williams, 1994). Taking into consideration of the entire proposition under the CBFM, it would be an issue of great interest for any researcher.

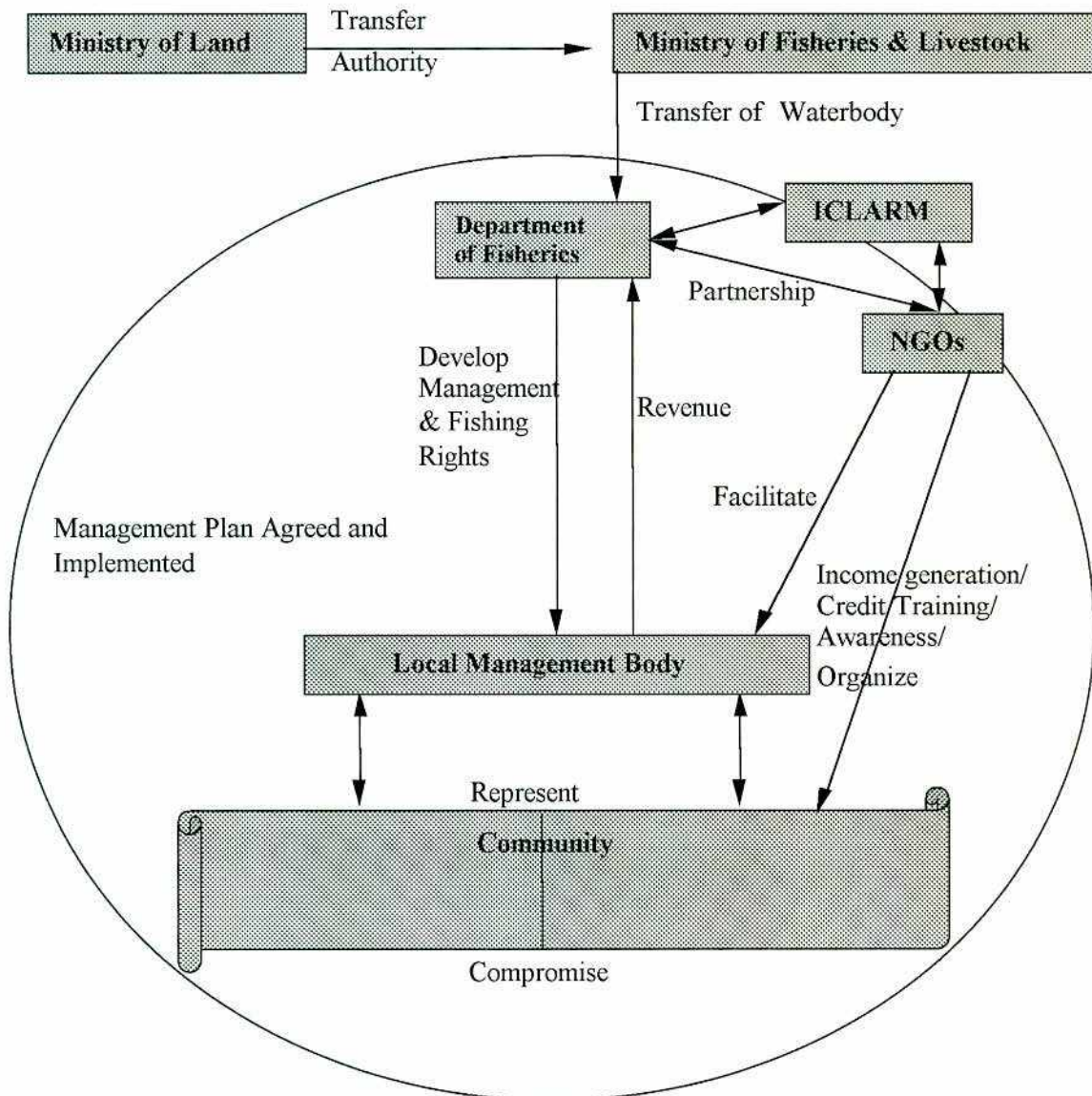


Figure 1.1: Schematic model of CBFM organization

1.2 Characteristics of beel fisheries

Beel fisheries traditionally supply a variety of fishes. The fishes those are grown naturally in the open water system are the prime sources of fishes of beels. The naturally grown fishes are dispersed throughout the floodplain habitat during the monsoon. With the receding of the floodwater in the late monsoon season, the water areas greatly reduce and the fishes get accumulated in the beels. Thus the beels, as a water body becomes important winter refuge areas, where the sheltered fishes complete their life cycle. This stock plays an important role in providing fish protein to the common people and fishing activity becomes source of income and livelihood for the fisher community of the resource specific area.

In augmenting the production, less importance was given on management issues through stocking the beels. Though management and production improvement of inland fisheries focused on stock enhancement of floodplains (Paul and Mazid, 1997; Ali and Islam, 1998) and oxbow lakes (Haque, 1999), which is rarely initiated in the beels (Alam *et. al.*, 1999). Department of Fisheries, however, released carp fingerling in some of the beels under its management during 1960s. Stocking of fingerlings was also initiated in some other beels under different project activities. In such stocking, scientific methods were seldom followed *i.e.* in the areas of species selection, ratio, size and density. Sometimes, stocking at higher density in the beel was reportedly known (Alam *et. al.*, 1999). But to utilize the natural food and the ecological zonation of any waterbody would be effective if it is stocked judiciously (Das *et. al.*, 1977; Nagel, 1979; Mustafa, 1986). Further regulation for fish conservation, protection, cost sharing was not ensured. Moreover, to organize and develop the users especially the fishers to learn and take responsibility of the management was not considered as an approach, which is the most important issue for beel fisheries development. The CBFM project was designed to address all those issues of fisheries management in open water, especially in beels, which was an area of special interest for this study.

1.3 Significance of social mobilization

The management options of CBFM project have focused on fisheries development by establishing fishers right, improve the status of the community and develop them for appropriation of resources through institutional development. During the implementation of CBFM, following activities have been carried out:

- Identification of fishers
- Community mobilization
- Group formation
- Training
- Fisheries management
- Institutional development

It was identified by CBFM project that if the above activities were carried out properly the objectives of the initiative would be served and the beneficiaries would become capable of resource management.

Beels are surrounded by the community people. Under the existing management system, the community rarely gets access to the beels as it is rented or leased out to the middlemen. Moreover, being detached from mainstream development efforts, the community is unaware of the access right, community-resources relationship, policy relevant information

and other necessary prerequisites those are needed to get benefit out of the beel resources. To relieve the community from such ignorance care was taken through social mobilization part of CBFM. Therefore, social mobilization of the community is dealt with great importance in this study.

Beel fisheries management needed an integrated approach based on firm knowledge of the community on fish production (Aguero, 1989). The production of any media not only depends on management, but proper guarding to prevent poaching the fish is similarly important. It can be possible with direct participation and responsibilities of the beneficiaries. Success of such involvement in management of natural resources is many (Begum and Alam, 1999). However, collective approaches of the beneficiaries are required rather than the usual isolation or compartmentalization of the fishers. Group formation, awareness raising, meeting, savings, training etc. are the tools of social mobilization (Alam *et. al.*, 1999). It is therefore important to look at the overall impact in the areas of community as well as fisheries management by the application of the above tools.

1.4 Hypothesis

From the discussions in the preceding sections it is now recognized that beel fishery is one of the significant fishery resources and constitutes an important economic sub-sector. In the context of Bangladesh and the socio-economic value of fisheries in terms of the contribution in the national GDP, it is of utmost importance that proper attention need to be given on the management of this sub-sector as there lies enormous possibility towards its gradual improvement.

To be able to derive maximum benefit without damaging the natural environment of the beels, there is no alternative to the proper management of this sub-sector. It is perhaps an established fact that if the beels and the resources therein are brought under proper management by ensuring the full participation of resource users especially the fishers, the production from the beels could be manifold and equity, sustainable resource management measures would ensure long-term impact. Besides the immediate and most visible gain out of the proper management effort, the capacity and the confidence of the community people who form the pivot of such management systems may also improve to a great extent, which are hardly measured in economic terms.

It was seen that all initiatives that were taken earlier failed to bring tangible benefit as involvement and participation of local community, especially the genuine fisher groups were not ensured. The sense of ownership on the initiative was absent as maximization of profit was the only criteria for the outsiders. The management of the resource cannot be fruitful if it does not sufficiently deal with the scientific, biological and the social aspect of

the entire management cycle. The advantages of community based beel management (through stock enhancement) are several:

- Fishers cooperate in planning to increase or conserve fish stocks, which is defined as improved management (sustainability).
- Fishers share costs and benefits of improved management (economic equity).
- Possibility of better conflict resolution among fishers (intra-group social equity).
- Being organized, the position of the fishers is fortified when dealing with other stakeholders.

When fishers have more control over fisheries, which they effectively own as a community, there is a greater trust between fishers and government.

1.5 Objectives

This study focuses on management of beel fisheries for promotion and enhancement of fish production and improvement of livelihood of the user community. By doing so it also investigates the role of the community, fisher groups, community organization and their interaction with the resources. The study further investigates the role of government, non-government and other supportive organizations for development of sustainable management practice.

Therefore, the overall objectives for the research have been aimed to assess the impacts of community based management in two beel fisheries of Bangladesh. The following specific objectives have been set out for the study.

- To investigate the process of community participation.
- To investigate the process of skill development and its impact on resource management as well as community development.
- To study the capacity building up process of the community in the area of institutional development.
- To study the water quality and biotic community of two beels.
- To assess the process of community based production enhancement initiative.
- To suggest management options for beel fisheries.

1.6 Rationale

It is evident from the above discussion that the beel fisheries contribute significantly in inland fisheries production. There has been limited number of studies on beel productivity and production in the developing countries. Also examples are few on beel management practice with participation of the user community. In fact, there is a need to look into the participation and development process of the community and how well it works in fisheries management.

The rationale behind selecting Hamil and Rajdhala for the study was also for the fact that there are quite some similarities, yet there are significant differences between the beels. From the following the areas similarities and dissimilarity features may be noted.

Similarities

- Both the beels are semi-closed and perennial.
- Stocking practice existed.
- Both the beels fall under the category of *Khas Jalmohal*.
- Respective Deputy Commissioner is the leasing authority.
- The beels are under CBFM Project.

Dissimilarities

- Hamil Beel community had their access right in the beel but this was not the case of Rajdhala beel community.
- Rajdhala beel was frequently leased out to outsiders while Hamil was always under the user community.
- Although not in a very structured form there was a management practice in the form of cooperative in Hamil beel but in Rajdhala it was totally an outside's prerogative.
- The Hamil community has had some experience of community mobilization through the work of Caritas under IMOF, which was absent in Rajdhala beel.
- Catchment area of Hamil beel is larger than that of Rajdhala although the size of Rajdhala beel is bigger.
- Natural productivity of Hamil beel is better than that of Rajdhala beel.
- The user community of Hamil beel is Muslim and in Rajdhala, they are Hindu.

The contrasting scenario as enumerated above, prompted the researcher to agree to the notion that in spite of the commonalties, there are quite some diversifications in both biological and social aspect of the resources. It was therefore thought pertinent to look

discretely to the inner dynamics of the situation and study the impact of Community Management through this research work.

The CBFM project has been designed to ensure community participation in the management process, so it is necessary to look into the impact of the community participation in beel fisheries management in Bangladesh. Lastly the findings of the study may lead to some plausible recommendations towards developing sustainable beel fisheries management both nationally and internationally.

1.7 Scope and limitations

The scope of the research work was limited to two beels namely Hamil beel and Rajdhala beel under Tangail and Netrokona district respectively in Bangladesh. It focuses on the local level and the community who use the beel for their livelihood generation.

The CBFM project started since January 1996. The study period covered the period of May 1998 to April 2000. The researcher had the opportunity to be actively involved from the designing and planning stage of the project to the implementation phases. So the recorded events and the related data from 1996 were extensively used in this study.

Like many other developing countries the fisheries sector of Bangladesh is characterized by a weak and insufficient database. Moreover knowledge of the various simultaneously interacting factors is inadequate. This situation would altogether make the use of most of the sophisticated techniques relatively unreliable. Literature is available on the topic of community, whereas availability of relevant literature on the fisheries community of Bangladesh has been limited.

1.8 Conceptual framework

The framework of the study was developed on the assumption that in order to manage beel fisheries in the inland water, critical concerns relating to the user participation and extent of management pattern along with other related factors have been explicitly considered. All these relating to various environmental concerns interact and influence each other. Figure 1.2 illustrates development of conceptual framework of the research.

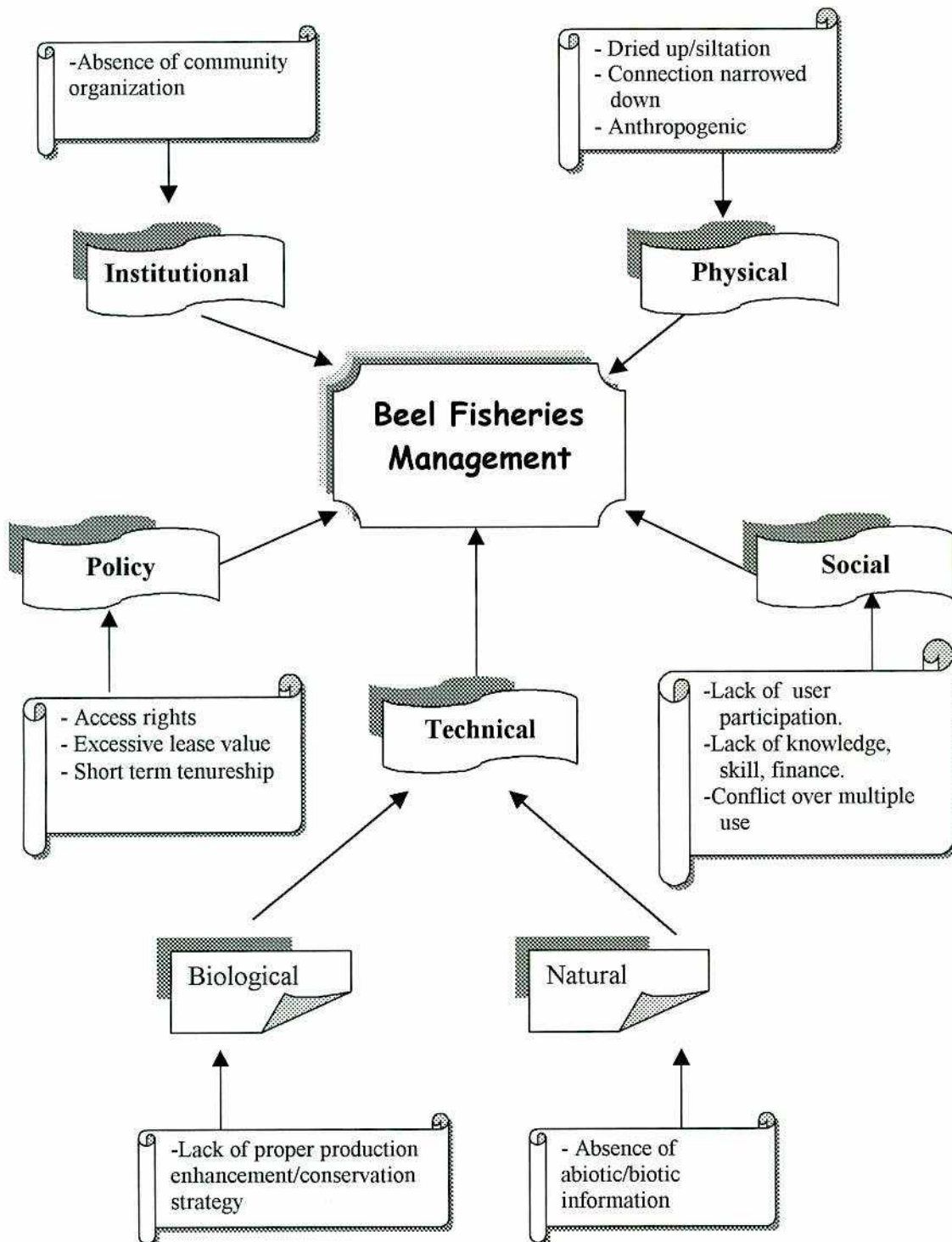


Figure 1.2: Conceptual framework of the research

CHAPTER 2

REVIEW OF LITERATURE

Beels belong to the inland open water fisheries resources. It is a typical and classified waterbody. In the past plentiful of fish resources gave rise to various local adages relating to the food habit and life style of the Bengali people. One such adage is *Maache bhate Bangali* meaning *Fish and rice make Bengali*. Another such adage is *Likhibo poribo moribo duk-khe, motshya dharibo khaibo shukhe* meaning *I would catch fish and live happily ever after rather than reading and writing which will only lead to my drudgery and miserable death* (Tsai *et. al.*, 1997).

For centuries fish has been central to the diet of Bengalis. During nineteenth and early twentieth century historical sources showed that between 85% and 95% of the Bengal populations were fish eaters (Ali, 1997). The rich and diverse nature of water environments in the Bengal provided the opportunity for the majority of the farming population to engage in fishing sometime during the year, something commented upon by many British colonial officials and observers from as early as the beginning of the 19th century. The days of those adage is now a legend of the past as scarcity of fish stock becoming discernible in the beel since about the mid nineteen fifties.

The scientific literature available on beel resources showed that information with regard to fish diversity, production status, beneficiaries interaction, etc., are limited (Ali, 1997; Rahman, 1995). The overwhelming majority of the references have focused on the management issues, environmental consequences, biodiversities, stocking and harvesting of this fishery. Several studies indicated the biophysico-chemical characteristics of beel fishery based on production and management systems (FRI, 1996; Price *et. al.*, 1996). Community based fishery management approach adopted and tested in some beels (DoF, 1996). Rahman (1995) presented a study on the environmental and social unrest due to beel management. The classical model of development especially capital and natural resources insensitive intervention has often led to unprecedented environmental degradation and happened to socio-economic deprivation in many areas as in Beel Dakatia where the above dilemma desecrated.

The extent of the diversity of floodplains is immense (Price *et. al.*, 1996) and beels are deep depressions within the floodplains (Ali, 1997). Therefore, it is often difficult to separate the beel fisheries from those other categories of open water types and define their characteristics. However, possible related literature reviewed and presented following aspects to highlight the importance of beel fisheries. The citation may not be comprehensive of the overall picture of the beel fisheries but it may be a profile of outcome of past research and study on the beel fisheries.

2.1 Types of beels and distribution

Bangladesh has extensive water resources within her boundaries. Water resources may broadly be classified into inland and marine sector and water between fresh and saline water is brackish or coastal fisheries (BARC, 1995). Bangladesh has the reputation of having very rich inland water. Ponds, lakes, haors, baors, beels, rivers and their tributaries and distributaries, canals, floodplains, etc. included in the inland waters. Among all the types, floodplains are extensive in areas (Welcomme, 1979). Beels are loosely included in floodplains or capture fisheries.

Beels are unique and special type of waterbodies by nature and characteristics. Beel is a local term and sometimes it is termed as *Jalmohal* or *Sairatmohal* (Rahman, 1989). Further, there are number of ambiguities in the definition, nomenclature and classification of beels adopted by various workers of the fisheries discipline. The word beel for example, is loosely defined and often used in common parlance to refer some of the small irrigation reservoir and included in the floodplain lakes that is called chaur, beels, jheels and pats (Sugunan, 1997). Considering its water retaining capacity it may be permanent or seasonal. Some beels are found as flooded, while some are closed. The characters of beels are like that of haors or baors. In fact, the beel, haor or baor are resemblance to each other. In monsoon period it is inundated and natural replenishment of fish stock takes place, graze and survive with adequate facilities. Considering the fish habitat it may include in open water capture fisheries resources. According to Ali (1997), beel is like that of reservoir as it has facilities to attract and holding various fish species.

Beels and haors both are natural depressions. The term haors are commonly used in Sylhet and Mymensingh districts while in other parts of the country the term beel used to denote these natural depressions (Rahman, 1989). However, haors are larger in size and concentrated in old Sylhet and Mymensingh areas. Beels are concentrated in the northern regions of the country (Ali, 1997; Rahman, 1989). According to the capacity of holding water beels may be permanent and seasonal. They also expressed that the permanent beels are deeper, larger and retain water all around the year. The large and deep depression also termed as haor. Haor lies between two or more rivers. These are generally bowl shaped. Beels are usually the lowest part of the haor. Sometimes each haor consists of one or more beels. During monsoon, when beels within haors are inundated, form a single sheet of waterbody. Some beels are formed due to change of river course leaving a segment, mostly permanent in nature having narrow or no connection with the original source, i.e., the river.

DoF (2001) survey indicated that there are 4,498 beels comprising an area of 114,161 hectares exists in Bangladesh. Ali (1997) stated that the numbers of beels in the northern

region ranges between 3,440 and 6,149 and covering area ranging between 585 km² and 635 km² respectively. He also stated that about 58% of the beels in the northern region are permanent and remainders are seasonal. Further, Rahman (1989) stated that the permanent beels have two types of fisheries, an annual fishery and a Jag or Katha fishery. In annual fishery, fishing is done by traditional netting or by de-watering. The Jag fishery is harvested every two or three years. In Jag or Katha fishery, fishing is done enclosing the Jag or Katha by traditional netting in every second or third year. De-watering is the normal harvesting technique in seasonal beels.

It has already been mentioned that the beels are concentrated in the areas like Sylhet, Mymensingh and northern areas of the country. Once the districts like Rajshahi, Nawabganj, Naogaon, Natore were famous for the plenty of beel fisheries. The Chalan beel is one of the famous beel located in those areas and spreading over the districts of Naogaon, Pabna, Sirajgonj and Bogra, (MPO, 1986). In the central region of the country beels are limited and few are existed in the districts of Dhaka and Munshiganj (Ali, 1997). However, once there existed various waterbodies either in the types of beel or of similar nature. Due to change of natural habitat and the rapid rate of destruction many beels converted or merged to general floodplain ecosystems (Khan, 1997).

2.2 Status of beel production

Bangladesh has the reputation of being very rich in inland open water fisheries resources and fish production. Compared with these resources per unit fish production (202 kg/ha/yr) is not much as high as in the neighbouring countries. DoF (2001) reported that the fish yield was 693 kg/ha in ox-bow lakes, 653 kg/ha in beels and 102 kg/ha in Kaptai lake respectively. World Bank (1989) stated the fish yielded in China was 412 kg/ha/yr and in India was 391 kg/ha/year. Rahman (1989) reported fish yield 1,890 kg/ha/yr from de-watered beels and drawn an experimental fishing result as high as 5,000 kg/ha/yr conducted by the Riverine Fisheries Research Institute.

Available data on fish production from beel fishery is limited (Rahman, 1989). In fact, due to lack of institutional support various forms of data and information cited by different sources. Production performance of beels and annual catch by districts, species composition and percentage of weight of beel catch for pile fishery and annual fisheries are meagre. This may often bears contradictory and a matter of arbitration. However, the sources laid sufficient reasons in support of statistics presented with regard to production level. Many problems encounter computing production level from beel or floodplain. Especially in the diverse areas part time or full time fishers particularly to the catch and made the system complex in estimation (Payne, 1997). Welcomme (1985) expressed his views that based on world wide data, floodplains production values varied and ranged from

40–60 kg/ha/yr. Bayley (1988) noted that maximum potential yields from floodplains may be 110–160 kg/ha/yr. Approximately an average of 590 kg/ha/yr fish production reported from the beels under different location of West Bengal (Price *et. al.*, 1996).

FAP (1993) referred its studies in the beel fisheries of the southern region stating that due to the implementation of flood control and drainage (FCD) and flood control drainage and irrigation (FCDI) projects, fish production declined. FAP-12 (1992) concluded the loss of beel fishery production 75%. In contrast very positive results demonstrated from beel through Community Based Fisheries Management approach (DoF, 1996). The production increased ten times due to implications of the approach. The production was 133 kg/ha in 1988-89 and raised to 1,256 kg/ha in 1996-97. This production level deserved special attention towards people participation in management of beel fisheries.

CIFRI (2000) reported beels are mostly dominated by major carps in West Bengal beels, where in some of the beels are minor carps occupied a prominent position in the catch. Many self-recruitment species (SRS)/small indigenous species (SIS) like *Gudusia chapra* also sporadically dominates the catch of some closed beels, but seasonally open beels. Fish yielded in managed beels 300 to 1,100 kg/ha/year (CIFRI, 2000), where it was reported 370 kg/ha/year in some beels of Bangladesh by BRAC/RDP (1999) and 1.1 to 227 kg/ha in some beels of India by Sugunan (1995). On an average *Catla catla* with an average share of 39.1% dominated in the stock, followed by *Cyprinus carpio* (20.2%), *Cirrhinus mrigala* (19.3%), *Labeo rohita* (19.0%) and *Hypophthalmichthys molitrix* (2.1%). Not only that *H. molitrix* could be stocked safely in beels along with *C. catla* and *H. molitrix* has lesser chance to dominate over domestic species and *C. catla* production was not considerably influenced by *H. molitrix* (CIFRI, 1997). Haque *et. al.*, (1996) reported the status of non-stocked indigenous fish promising in oxbow lakes, Jessore, but introduction of large scale stocking of carps (Indian major and Chinese) in these waterbeds is thought to have imbalanced homeostasis of lake ecosystem and its biodiversity. They also reported a monthly production yield of non-stocked indigenous fish excluding Clupeids in these two lakes, *i.e.*, 27 kg/ha (Bukbhara lake, Jessore) and 30 kg/ha (Kannandah lake, Jessore). On the other hand, it was 78 kg/ha and 32 kg/ha including Clupeids. Middendorp *et. al.*, (1996) reported fish productivity of oxbow lakes as when it is treated as capture fishery, the fish yield would be less than average 200 kg /ha/year, whereas while it was under culture-based, the fish yield is over 500 kg/ha/yr.

2.3 Management options of the beels

The inland fisheries sector of Bangladesh is divided into two sub sectors viz. capture fisheries and culture fisheries. People of Bangladesh could not realize the importance of management of any sector of fisheries during 1950s (Tsai and Ali, 1997). It was common belief that the fishes are the nature's free gift and nature will continually sustain these living resources. Man's common job is to harvest the fishes with free of cost. This perception led to the indiscriminate harvesting of these resources and management or improvement was questioned. The indiscriminate harvesting caused overfishing and led to the depletion of natural stock. However, to develop the fisheries sector emphasis has always been laid on the improvement and expansion of the culture based fisheries sub sector. The floodplain or open water or capture fisheries has always been neglected or ignored (Rahman, 1989). Nevertheless, though of late several management options either suggested or tested in improving the complex habitat of beel or floodplain systems (BCAS, 1993; Rahman, 1995; ; Hussain, 1997; Price *et. al.*, 1996). The impact of similar studies on habitat, social and economics, biodiversity, production etc. are reported by Minkin *et. al.*, (1997) and Hussain (1997).

The leasing system was one of the most crucial issues facing management of beel fisheries. Under the lease system beels are leased out to the highest bidder. The system found undesirable for many reasons (Siddique, 1981; Khan, 1985). Under the system there was a tendency of maximizing profits through intensive overfishing or de-watering resulting depletion of natural stock and damage biodiversity. To protect the beel habitat and fishing rights licensing system was introduced (GoB, 1987). In licensing system, rights of beel fishery through selling were replaced and fishing rights directly given to the fishermen (Siddiqui, 1989). Siddiqui (1989) further analyzed the problems in licensing and leasing systems and noted that there were no basic differences between these two systems introduced in 1973 and 1987. However, the potentiality of licensing system has fulfilled the objectives of production and equity in the beel fishery systems.

Some development activities like embankment project created management disaster in beel fishery. Beel Dakatia is an example of environmental consequences. Rahman (1995) studied the effect of continued water logging created due to stopping of natural flow of water and water logging induced siltation and congestion of water. The agricultural production was seriously affected. The trees, livestock, fisheries, education and health institution were adversely affected. The fish species of beel Dakatia area declined. Fish diseases appeared due to deterioration of water quality. Some other studies also restricted to environmental changes by embankments in canals or beels fisheries (Minkin *et. al.*, 1997; Hussain, 1997). Minkin *et. al.* (1997) suggested that community based conservation and restoration of beels habitat for sustainable fish production subsidizing fish harvest.

Few other water resources development projects either implemented or are being implemented in various forms created hazards to the open water resources and their consequences studied (Hill and Manchelt, 1995; Tsai and Ali, 1986). The flood control and drainage (FCD), Flood control, drainage and irrigation (FCDI), Closures of rivers and canals, channels diversions, withdrawal of water from rivers and beels for irrigation in the dry and lean seasons are the examples of such water resources and development projects (Ali, 1997). These projects were planned, designed and implemented basically making low lands flood free and dry for foodgrain cultivation throughout the year, prevented submersion of human properties and belongings and loss of domestic animals during exceptionally high flood years and provided crop irrigation with surface water from rivers and beels. Hundred of water resources projects of similar nature implemented in Bangladesh since 1960 (MPO, 1986). However, impact of such projects were never been considered and ignored. As a results many of beels either dried or became inland seasonal from perennial. Consequently many species of inland open water fishes and other fisheries resources have been threatened with extinction.

FAP (1993) studied the situation of beel fisheries in the southwest region of Bangladesh. Since the development of water resources management projects (FCD and FCDI) in 1993, many beels were drained under different projects for claiming additional rice growing lands. Many were converted perennials to seasonal waterbodies.

The management consequences of FCD and FCDI projects were also studied and reported by ODA (1997) under separate project title named FAP-17. It undertook investigations solely on biological and socio economic aspect of open water. The consequences of the activities are many. Due to the establishment of FCD and FCDI projects fish habitat lost, catch per unit area and abundances reduced, fishing effort and intensity increased, migration and biodiversity lost. However, a newly device namely *fishpass* designed and installed in some haor under flood control project (FAP-6, 1995). The *fishpass* is a series of pools installed to aid fish in-migrating across the full flood embankment from river to haor. The fishpass offered the possibilities of recovery of portion of the production of haor biodiversity. The environmental restoration denoted as an alternative approach and may encourage the reestablishment of diverse indigenous fish species population.

The access to open water systems introduced indiscriminate fishing and over-exploitation of the fisheries resources (Aguero, 1989). Such intervention destroyed biodiversity and declined fish production level in open water systems. The pace of such changes has been accelerated adopting different management options. The policy for open water stocking was initiated to replenish the balance of open water stock (DoF, 1985). However, the impact of carp fry stocking on socio-economic of subsistence fisher groups studied and reported (Minkin *et. al.*, 1997). Carp fry stocking program created problems by restricting

common property fishing rights and subsidizing fish harvest monopolies. It is cleared in the study that open water stocking has created repercussions for poor families who depend on beels or floodplains. Access to fishing has been greatly restricted where large scale stocking has taken place. As a result, a system of fishing rights and heritage evolving over centuries has been attacked in order to protect the open water stocking policy. While stocking with native and exotic species in a common management tool for stock enhancement, there is little evidence for or against its biological and economic effectiveness (Jhingran, 1997).

Considering its polyculture perspective, there is one distinctive management regime adopted where the beels are stocked. There are no management regimes at unstocked beels (Price *et. al.*, 1996). The strategy followed in stocked beels are protecting the fishes from poaching, treated if diseased, liming the water, resists over flooding, regular harvesting and marketing, etc. (Alam *et. al.*, 1999). Generally food is not used or fertilizers are not spread over in the stocked beels. Often the beels are stocked twice a year with mostly major carps and exotic carps.

Generally stocking is not the only way of increasing production. In context of increasing production, importance of social issues have been over time realized and Community Based Fisheries Management (CBFM) approach adopted in addressing social issues (Begum *et. al.*, 1997). The principal features of the CBFM approach are to organize and motivate fisher community and mobilize them socially to ensure their access to the resources. Various studies have reported the importance of establishing fisher groups for self-management of waterbodies (Apu and Middendorp, 1997; Thompson *et. al.*, 1997; Khan, 1997). With regard to the management large scale poaching of fishes by other rural poor considered as major constraint of enhancing the production of stocked fishes (Apu and Middendorp, 1997). In controlling the poaching fisher groups should be large and formed selecting the members from all villages or neighbors around the waterbody.

2.4 Ecology of the beel

About 6.7 percent of Bangladesh is always under water, 21 percent is deeply flooded (more than 90 cm) and around 35 percent experience shallow inundation (FAO/UNDP, 1988). Apparently the wetlands are static, inert and unchanging. In reality, they are self-destructive eco-systems, which are in a process of transition from permanently wet to generally dry environment. In the ultimate analysis, the wetlands are doomed to die. Usually the natural process of change takes place so slowly over so many years that it may seem that nothing at all is happening. Sometimes however, the process of degeneration of wetlands is accelerated by natural change or human intervention.

Chalan Beel, the largest waterbody in Bangladesh, experienced rapid siltation in the early twentieth century owing to natural causes. It was estimated in 1916 that about 169 million cubic feet of silt were being deposited in Chalan beel every year. About a hundred years back, the area of the beel stood at 421 square miles. In 1909 it shrank to 33 square miles, in 1913 it was further reduced to 12 to 15 square miles.

In recent years, human intervention has speeded up the loss of wetlands in Bangladesh. Significant increase in population since the late nineteenth century necessitated dramatic expansion of cultivated areas in wetlands for improvement in the supply of food grains (Khan, 1997). Moreover, all wetlands are flood prone and hence agricultural practices have been adjusted to minimize the risk of flooding.

For millennia the inhabitants of Bengal delta had lived with floods. Though embankments are the simplest and oldest techniques for flood mitigation, large-scale embankments were unknown to Bangladesh before 1960s. The construction of massive flood embankments started with the establishment of East Pakistan Water and Power Development Authority in 1959. Nearly 20 percent of the total area in the country is protected by 6,134 km embankments, 4,521 hydraulic structures and 958 river closures (MPO, 1986). They protect crops against early floods and in some case rotation of waters.

The rapid expansion of physical infrastructure in the floodplains and wetlands in Bangladesh yielded two beneficial effects. First, food grains product increased from 11.9 million tons in 1669-70 to 18.33 million tons in 1990-91. Much of the increased production came from the irrigated areas in wetlands. Secondly, rural roads contributed to alleviation of poverty through generation of employment, adoption of new agricultural technology and increasing income of poor (Tsai and Ali, 1997).

Though the immediate benefits of physical infrastructure are well known the adverse effects of the tragedy of wetlands in Bangladesh have not, however, been catalogued as yet. Various water control projects have reduced the size fish habitats, embankments impede the migration of river breeding fishes, prevent the movement of newborn hatchlings to grazing grounds (Tsai and Ali, 1997). An evaluation of Chandpur Irrigation Project indicated a 35 percent decrease in total fish catch in the first two years after the project became operational (MPO, 1987).

In many countries the rate of wetland loss has reached the proportion of national crisis. In the developing world wetland loss is leading to substantial impacts upon local communities, which depend upon these resources.

Most of the inland and offshore river dependent species of fish are seriously threatened as a result of flood control interventions such as embankments, sluice gates and rural roads. For instance, major carps, such as the catla, mrigal and rohu, which used to account for up to 20 percent of open water fish catch now constitute less than one percent (BCAS, 1994).

In dry months, the dried beels are converted into either cultivable land or grazing grounds. In few cases, dry beels remained fallow and various semi-aquatic plants emerged. Karim (1993) mentioned the occurrences of about 158 species of plants belonging to 49 families in the beel ecosystems. During floods nutrients are carried into the floodplains (beels) with dispersion of plants and terrestrial animals (Dister, 1990). Aquatic fauna takes advantages of flooding water and move between inflow and outflow within the flooding basins of beels or floodplains. NERP (1994) reported that increases the flooding resulted increase in fish production to 15.6%. The open or flooded beels are characterized by a transition between flood and dry stage. Because of their large supply of water and nutrients, the (beels) floodplains are one of the productive ecosystems on the earth (Dister, 1990). As a result of their peculiar habitat and critically interlink with other common water resources of floodplains, balance in the beel ecology is a matter of critics and beel ecosystem always changed and influenced as the changes occurred in other floodplain systems. Not only the aquatic life, human life or the agrarian systems are also influenced due to the changes occurred in beel ecosystems. A vast majority of people directly depends on the beel sector for their economy and day-to-day survival. In the haor system people conserve swamp forest and wildlife. Therefore, conservation of beels or floodplains for multiple uses always felt needed. Any attempt of conservation of beel resources into single crop agriculture may be a suicidal for other dependant (Khan, 1997). The beel when inundated during the monsoon period crossed its normal boundaries and engulfs the adjoining private lands and become common property. As a result the scenario of beel ecosystem completely changed and peculiarities occurred in the prevailing biodiversity. Similarly, when water recedes after monsoon, beel areas physically reduced, ecological characteristics also changed and become detrimental to the life process of beel dwellers (ODA, 1996).

A total of 276 species of wildlife have been reported in the floodplains of Bangladesh (Khan, 1997). According to Sarker (1993), 282 out of 650 species of wildlife are known as freshwater wetland species in Bangladesh. Floodplain offers different habitats for wildlife. The habitat preference of larger terrestrial mammals and aquatic wildlife in relation to flooding and changes in the habitat when floodplains go under water. Not only from one place to another but from time to time another wildlife habitats differed. Khan (1997) reported diverse ecosystem of diverse plants and animals from Tanguar haor and Hail haor respectively.

2.5 Limnology of the beel

The researcher conducted limnological works on all types of water bodies and factors that are harmful or harmless for aquatic habitat after generation of knowledge on limnology (1892). The same type of study was carried out in the lake Geneva (Cole, 1983). Initially, limnological works were limited to the lake based study in Bangladesh. In temperate and polar waters, considerable research was done on the plankters, benthic habitat and their seasonal or periodical fluctuations (Smith and Swingle, 1939; Villadolid *et al.*, 1954; Ellworth, 1983) from various waterbodies under different management systems.

The scientific literatures available on limnological aspects show that there is a wealth of information on this area of study belonging to these regions of the world (Alikunhi *et al.*, 1948; Ganapati *et al.*, 1953; Banerjee, 1967; CIFRI, 1997, 1999, 2000). In spite of especially under management practices are limited (BCAS, 1993 and Khan, 1997).

As the importance of beel fisheries realized, the limnological aspects have been taken with great enthusiasm, which in turn will help to increase the management capacity. Most of the aquatic biota obtains all their nutrients from the media they live. The biochemical composition of water is responsible in many cases for the regulation of growth and abundance of flora or fauna (Healy and McCall, 1974). There are reports that the dust and clay particles in water may contain some nutrients accessible turbidity of soils and clay. The suspended materials settle down in the bottom of the beels or floodplains and allowing a good growth of algae and aquatic macrophytes (Paul, 1997). This natural feed grown in the system helps in fish growth and production.

Therefore additional feed is not required to supply from outside for the fish in floodplains. Further the fertilizers used in adjoining agricultural field along with leftover of cropping systems or straws decomposed in the field provides additional nutrients to the fishes (Rahman, 1989). But too much organic load may affect adversely to the environment thus jeopardize fish yield. Extensive jute rotting and associated activities result in deterioration of water quality and occasional fish killing at many ox-bow lakes and beels (FAP, 1995).

Due to rotting, acetic acid, lactic acid and butyric acid load increases. As a result pH reduced for short time, increases total alkalinity, ammonia and free carbon dioxide contents in water and drastically decreased dissolved oxygen level, which often results in severe fish kills. Generally, the productivity of beel is determined by its diversity (Paul and Mazid, 1997). But extent of flooding and length covered during flooding consequences are also governing the limnology of floodplains (BCAS, 1993). In some beels, having considerable coverage of aquatic macrophytes and paddy are dominated with detritus food chain (Paul, 1997). In some other studies report elsewhere that fish stock and production

adversely affected by human activities that causes the increase of suspended particles and changes the flow rate, salinity and pH (Price *et al.*, 1996). They also observed that the factors namely dilution of flooding water, washout of ground nutrients from irrigation and absorption by living components of the system, etc., combinely given higher levels of nutrients in the shallowest parts of the ox-bow lakes (floodplains) particularly, due to solution of ground nutrients from newly inundated land.

As mentioned above, there is limitation of information on limnology of beels fisheries (BCAS, 1993 and Khan, 1997). But generation of knowledge on limnological aspects started a couple of decades back (Smith and Swingle, 1939), showed that the fish production was related to the plankton production.

Alikunhi (1957), confirmed that in Madras state of India, water of pH 6.5 to 7.5 gave average yield than that of pH 7.5 to 8.5 in two ponds. The average pH values of both the ponds were 7.5 ± 0.16 and 7.4 ± 0.16 . In this regard, Michael (1969) found that the year-to-year variation in the total quality of plankton highly affected the growth and production of fish in a study in seasonal variations of the physico-chemical factors and plankton of fresh water ponds in India. The amount of dissolved oxygen in the ponds was found to be dependent on various biological processes taking places in the medium.

Khan and Siddiqui (1974) investigated the seasonal changes in physical, chemical, and biological characteristics in a perennial fishpond at Aligarh. The transparency was found affected by turbidity and phytoplankton crop. Zooplanktons were mainly reported by rotifers, cladocerans and copepods. They observed an inverse relation between phytoplankton and zooplankton. Mollah *et al.* (1979) found a more or less direct relationship between pH and dissolved oxygen content and an inverse relationship free carbon dioxide and pH.

Ali *et al.*, (1989) recorded the seasonal variations of physico-chemical and biological condition in a pond. They observed considerable variations in water qualities in different seasons. Rahman (1992) observed that because of the tolerance limit of most aquatic organisms is pH 5-9, serious problems can result if the buffering capacity of their habitat is disrupted. Khan *et al.*, (1990) reported that the productivity of water bodies is related to pH. High seasonal pH condition in the water may pose some health hazards. Hardness of water quality is directly related with the biological productivity. Hardness above 500 mg/l is unsuitable for domestic use, 170 mg/l is termed as good quality water. Begum *et al.*, (1994) reported the fluctuation in the physico-chemical parameters of semi-intensively managed fish ponds. They compared the degree of variability of each physical or chemical parameters. The pH value of the pond was found to have the lowest variability while carbonate had the highest variability. Hossain *et al.*, (1997) studied the physico-chemical

parameters of the Basukhali-Salimpur-Kola-Barnal (BSKB) beel, a completely closed system flood plain. The turbidity values of the flood plain was almost translucent, conductivity values were found higher in comparison to some other aquatic ecosystems and dissolved oxygen maintains an inverse relationship with temperature.

Floating organisms whose movements are more or less dependent on currents called plankton. While some of the zooplankton exhibits active swimming movements that aid in maintaining vertical position, plankton as a whole is unable to move against appreciable currents (Odum, 1971). Das and Srivastava (1956) reported a bimodal pattern of plankton production in freshwater ponds of Uttar Pradesh. While the planktonic peaks in these ponds were recorded in spring and monsoon, the troughs were discernible during summer and autumn. Bhowmick (1968) who also reported a bimodal pattern of plankton production in Kalyania fish farm ponds (West Bengal) observed the maximum occurring in monsoon and winter. The monsoon peak persisted till October and was invariably dominated by phytoplankton.

The winter peak was dominated by zooplankton. Michael (1969) observed in a freshwater pond at Barrackpore, a single, though prolonged, peak period lasting from January to April. Patalas and Patalas (1968) carried out an investigation on the composition and seasonal changes in plankton and observed that number of species were greater in deeper than in the shallower water and found a relationship between the plankton abundance and electrolyte content of water.

Patnaik (1973) from a study on the seasonal fluctuation of plankton in the Chilka lake and reported that the plankton biomass in different sectors showed somewhat similar pattern of fluctuation with a summer peak during April-June, a monsoon peak in July-August, a winter peak during October- December and a spring peak in February. Das and Bhuiyan (1974) recorded fifty seven species of planktonic organisms including 25 rotifers, 14 cladocerans, 10 copepods and 8 Ostracods from 2 ponds and 2 lakes of Dhaka city. The greatest abundance of Plankton was observed in the months of April, May, October and the greatest depletion was observed in the months of August and January to February. Mollah and Haque (1978) studied the monthly variation of plankton in relation to the physico-chemical conditions of water.

The physico-chemical characteristics of water were found to have some effects on the plankton. Patra and Azadi (1987) made a qualitative and quantitative study of plankton in relation to physico-chemical factors of the Halda river water. Zooplankton growth cycle was noticeably less than the phytoplankton abundance almost throughout their study period. Hossain *et. al.*, (1997) studied the qualitative and quantitative status of the plankton

of BSKB beel. They identified a total of 102 genera of phytoplankton and 33 genera of zooplankton.

Rotifer was the most abundant group. Both the zooplankton and phytoplankton exhibited common peak in May. Zooplankton showed a second peak in September. Saha *et al.*, (1988) studied the quantitative and qualitative characteristics of planktonic biomass in the ponds. The production of zooplankton in the ponds was higher than that of phytoplankton. Chowdhury *et al.*, (1989) observed the occurrence and seasonal variation of zooplankton in a fish pond in relation to some physico-chemical factors.

They recorded the major group of zooplankton and distribution of their monthly percentage. Rotifers appeared as the dominant group (52%) followed by protozoans (16%), and ostracods (12%). Begum *et al.*, (1992) investigated the occurrence and seasonal variation of zooplankton in a semi-intensively managed pond in Dhaka city. The highest number of rotifers was recorded in April and the lowest in May. Green (1965) made a quantitative study of zooplankton in shallow lake which contained the largest standing crop of zooplankton and higher concentration of nutrients salt. Nayar (1965) made a quantitative study of zooplankton in relation to physico-chemical factors of the water and showed that pH and dissolved oxygen content of water significantly influenced the abundance of the zooplankton. Munro (1966) reported 17 genera of zooplankton including Rotifera, Cladocera, Copepoda, and Diptera.

The highest number of rotifera was recorded in November and the abundance of Copepoda and Cladocera was observed from January to February. He further suggested that abundance of plankton was directly related to the availability of nitrite and nitrate nitrogen. Watson and Carpenter (1974) stated that the number of zooplankton fluctuation markedly throughout the seasons with maximum in the spring or summer months. Nordlie (1976) studied the seasonal abundance of zooplankton. Rotifers were found to be the most abundant in the cold months while the cladocera showed the highest densities during the summer months of the year. The copepod and its nauplii were variable throughout the year and showed spring summer and late fall peak in abundance. Kabir *et al.*, (1997) made a quantitative and qualitative study on the zooplankton from Noakhali North flood plain. The study revealed the occurrence of eight taxa of Euglenophyceae, 1 species of Danophyceae, 35 taxa of Monogenata and 14 taxa of Crustacea. They reported 10 new records of zooplankton from the area. Alam *et al.*, (1987) studied on the status of phytoplankton in four newly dug ponds and their relation to some meteorological and limnological factors. They observed that occurrence of phytoplankton was irregular in all the four ponds. Myxophyceae, Bascillariophyceae and Chlorophyceae were the most dominant groups. Unfavorable meteorological and limnological factors prevailing in the ponds were the causes behind the poor productivity of phytoplankton. Various correlations between

phytoplankton and limnological factors were established. The positive correlation with dissolved oxygen and pH and inverse correlation with the free CO_2 were highly significant at 5% level of productivity.

Mumtazuddin *et. al.*, (1982) studied the limnological conditions of four selected rearing ponds at Aquaculture Experiment Station, Mymensingh. Vertical and forth nightly variations of temperature, transparency, depth area, dissolved oxygen, free carbon dioxide, total hardness, pH, and plankton were observed. They found 33 genera of phytoplankton belonging to Chlorophyceae, Xanthophyceae, Chrysophyceae, Bascillariophyceae, Euglenophyceae and Myxophyceae and 44 genera of zooplankton belonging to crustaceans rotifers.

Srivastava (1959) reported on the bottom fauna of some ponds of Lucknow and stated that it exhibited seasonal fluctuations, its total volume being highest during monsoon months attributable to the dominance of mollusks and oligochaetes. Bhowmick (1968) reported that the volume of bottom organisms in ponds of the Kalyani fish farm in West Bengal showed a unimodal pattern of distribution during the year with a single broad peak spread over winter and early summer months (January to March) and a single trough during autumn (September to October). The winter-early summer peak was constituted mainly by chironomids. However, in numerical abundance, benthic fauna, represented by oligochaetes and crustaceans, was at its peak abundance during monsoon.

Thieneman (1925) stated that a lake is poorly productive when it produces 1000 animals/ m^2 or less than it whereas a concentration of 2000 animals/ m^2 or more in a square meter is considered as highly productive. Tressler *et. al.*, (1940) observed that in Buckeye lake of Ohio depth played an significant role in the distribution of benthic organisms. Welch (1952) fond that the nature of the bottom deposit is an important feature in determining biological productivity of a lake and the benthos vary widely with different conditions of the bottom both of the same level and different depths. He also considered the temperature to be a controlling factor in the distribution of bottom fauna. Buscemi (1961) noted the highest biomass of macrobenthos within the range of 0.6 meter depth in Parvin lake in Colorado.

Lellak (1965) pointed out that the main factors influencing the dynamics of the development of macrobenthos are the source and supply of food and the direct and indirect influence of the number and species composition of fish stock. Sitaramiah (1966) observed the population of chironomids remained small from October to December but was large in January and February. Monakov (1969) reported that Oligochaeta and Chironomidae larvae are valuable as food for fishes.

Ali and Haque (1977) studied on aquatic Oligochaete of Dhaka city with short note on their ecology. They observed more than a hundred specimens during experiment. *Dero vagus*, *Dero digitata*, and *Stylaria kempfi*, were reported from the country for the first time. Rahman *et. al.*, (1975) discussed the ecology of fish ponds with special reference to bottom fauna. They reported that the main constituents of the benthos were oligochaete, dipteran larvae. Growth of fish was found related to the concentration of the bottom fauna. Ali *et. al.*, (1981) investigated the population dynamics and biomass of oligochaete fauna of a fish pond and role of physico-chemical factors on their population. The maximum abundance of different species occurred at different times of the year. The highest peak of the population, taking all the species together was recorded in February with 1,710 individuals/m² and the lowest peak in October was 22 individuals/m² maximum and minimum biomass was obtained to 10 gm/m² and 0.06 gm/m² in February and October respectively. Tudorancea *et. al.*, (1978) studied on the structure dynamics and production of the benthic fauna in Lake Manitoba and reported that the benthic fauna of freshwater was constituted to be the subject of much research in the fields of ecology and hydrobiology because of the importance of benthic organisms in the nutrition of fishes and as biological indicators of aquatic pollution. Ali *et. al.*, (1978) studied the bottom fauna of Dhaka city with seasonal abundance, percentage composition and biomass of three ponds.

A total 58 species were recorded. Chironomids, oligochaete and molluscs were found as dominant group. Ali *et. al.*, (1981) studied macrobenthos of nursery pond at Zangalia fish multiplication farm in Camilla in relation to the climatic and physico-chemical properties of water. A total of 30,350/m² were recorded from A,B,C sampling stations. Highest number of individuals was recorded at station A (15,644/m²) and lowest at station C (6,842/m²). Major groups of organism were found the chironomid and oligochaete. Das and Islam (1983) studied as the macrobenthos of an artificial pond in the Agricultural University campus. The number of bottom fauna was maximum in December and minimum in May. The peak abundance of chironomidae was in December and Oligochaeta in July, Ceratopogonidae in December and Mollusca in July. Ahmed *et. al.*, (1991) studied the macro-benthic fauna of Kaptai lake. The abundance of total benthic fauna varied from 99 ind/m² in September to 163 ind/m² in December, chironomid larvae oligochaete and pelecypods were the dominant groups and consisted 44.6%, 36.62% and 12.21% of the benthic population. Chironomids showed an inverse correlation with oligochaetes in their study.

Latifa *et. al.*, (1997) investigated the qualitative aspects and zonal distribution of benthic macro-invertebrates in relation to some physico-chemical factors of the water and showed that temperature, dissolved oxygen and free CO₃ content of water significantly influenced the abundance of the benthos but alkaline pH had no influence on benthic density.

Oligochaetes predominated over all other groups of benthos and constituted about 55.19% of the total population.

2.6 Community Participation

There are about 13,000 water bodies (Jalmohals) of different sizes including rivers, haors, baors and beels in Bangladesh, which are significant sources of subsistence and livelihood, especially for poor people in developing countries (Hossain, *et. al.*, 1998). About 75% of the rural families are engaged in seasonal consumption of fishing in floodplains, khals (canals) and beels (DoF, 1989). The poor, although often regarded as the proximate agents of resource destruction, are also usually its first victims and thus have a major stake, perhaps more so than other users, in the management and conservation of resources (Capistrano, *et. al.*, 1997).

A common property resource such as the Beel is broadly defined as a natural resource in which a group of people has common user rights. Traditionally, the CPRs are not open-access, but are subject to rules and conventions, often unwritten, of local communities. Community Based Fisheries Management (CBFM) is recognized as a proper management approach as community based management strives for a more active people's participation in the planning and implementation of fisheries management (Pomeroy, 1994). Community based management is seen as an alternative and possibly improved approach for managing common property resources, such as fisheries (Kuperan *et. al.*, 1994).

In view of the above proposition, it is important to look into the inner dynamics of involving the community in the process of management. Organizing the community is believed to be the introductory task to begin with the process of participation. Since organizing the community has been viewed as an essential element, then the participation of the community in the process is also very crucial. Participation is a concept with multiple meanings (Rozario, 1998). Various aspects of the concept have been debated at length, for example, its historical origin, its theoretical connotation and practical applicability. To make participation meaningful, it must involve some direct access to decision-making and the active involvement of the beneficiaries in determining problems and practices (Oakley and Marsden, 1984).

Stakeholder analysis through Participatory Rural Appraisal (PRA) and Focus Group Discussion (FGD) helps in clarifying roles and responsibilities at different tiers of the functionaries. Stakeholder analysis identifies who has a stake, the nature of their interest and clarifies the relationship between the groups (Hoggarth *et.al.*, 1999). It may be noted that participatory approaches may not be applied specifically to aquaculture but are used to undertake an overall assessment, led by local people, to identify key problems and

potential that might include aquaculture along with a range of other developments (FAO, 2000).

Organizing the community members normally is done under some platform that forms the common interest group. Forsyth (1990) says that people join groups to achieve extrinsic goals, which they would be unable to achieve individually. According to Forsyth, the sharing of common goals is one of the strongest unifying factors within groups, and it motivates individual group members to behave in ways that result in the group's successful goal completion. The reality of a group emerges out of people's common perceptions of themselves as members of the same social unit and in various relations to one another within that unit (Asch, 1952; Sharif, 1966). The International Glossary on Poverty (Gordon and Spicker, eds., 1999) defines participation as referring primarily to the process of involvement in decision making. It is seen as both an empowering and educative process. They believe, for example, that the only way poor can overcome their difficulties is by directly participating in the process of development, including participating in the formulation of policy in development program implementation and sharing in their benefits.

Sen and Nielsen (1996), while making a comparative analysis of case studies on fisheries co-management. They also observed that if the resource user groups are homogenous either functionally, territorially or socio-economically, it contributes to group cohesion. They further observed that where there was socio-cultural heterogeneity in multi-user group situations, co-management was more difficult with government taking bigger role in decision-making. Lewin (1948) believed that groups come into existence in a psychological sense not because their members necessarily are similar to one another; rather a group exists when the people in it realize that their individual fate depends on the fate of the groups as a whole. It is not similarity or dissimilarity of individuals that constitute a group, but interdependence of fate (Costa, 1999) He further observed that while mobilizing occupational groups, most supportive agencies also organize women groups with equal emphasis on the assumption that sustainable changes cannot be brought about by ignoring the contribution of half of the total population.

Economic growth theories see development as a process of capital formation, which, in turn, is largely determined by levels of savings and investment. It has been observed that saving services that provide the saver with security, convenience, liquidity and returns, represent a crucial financial service for low-income clients (Robinson, 1995). Yunus (1983) in his paper on "Group based savings and credit for the rural poor" observed that the poor represents the majority section of the population but unfortunately the fruits of their labor are usurped by the better-off segment of the population through economic, social and political manipulations. All these manipulations find their strength in the control

over financial resources. He further added that if the control over financial resources can be loosened, the poor can at the very least begin to enjoy some fruits of their labor, expand their economic base, live their lives with dignity and look forward to building better lives for themselves.

Costa (1999) observed that while savings build up the economic base of the organized mass, the need of different kinds of trainings are of equal importance. He observed that that the supportive agencies consider training as direct investment in people to help create motivational awareness of the members and develop their capability for greater participation and initiatives by the members to bring required changes. Training is also important not only for the development of skills of the members but it is also important to address the sustainability issue of the initiative. Pomeroy (1994) by quoting Mary Racelis affirmed that people who are organized, aware of their rights and ready to exercise them, and partners in the planning and implementation of resource management systems, can bring about sustainable development. The necessity of introducing proper fisheries management practice required skill trainings. Hoggarth *et. al.*, (1999) also subscribed to the above proposition by observing that Fisheries Management needs people with skills in many areas, from technical skills for the assessment of the fishery to social and management skills for encouraging cooperation and reducing conflicts.

There is a need to have an institution and or organization of the poor who can cater to the interest of the community and actively response to the need of the community. At the same time, the role of an institution is also seen as a regulatory agency. Without the presence of a body that is democratically elected by the resource users there could be chaotic situation that may ultimately lead to the eradication of the initiative. McGoodwin (1990) observed that the larger the group, the more people who will want to have input, and the greater the chances for conflicts to arise which will inhibit the decision making process. Costa (1997) pointed out that institution building of the poor is understood as the fundamental concern as well as a key to sustainable development and establishment of right of the poor.

Ali (1997) observed that all activities of 1990s (TFP, ADB, IFAD, CBFM) appear to have emphasized management of water bodies to earn a revenue income of government from the policy of land to increase Jalmohals rent by 25% or even 10%, every year. He further observed that revenue fixations remain in the hands of the administration, which do not have much understanding on fish growth biology, which affects production potential of the resource.

It would therefore be seen from the above observations that development of fishermen community has not been addressed in consonance with the livelihood development of the community, rather it was linked with revenue earning by the government. Unfortunately

fisheries remain one of the least valued of the various uses of water and in many areas institutions making decisions on the allocation of water do not even consider fish (Hoggarth 1999).

There are however, other conditionalities other than community management for ensuring proper resource management. Pomeroy and Williams (1994) pointed out that Community-based management is not a panacea for resource management. It may not be suitable for every fishing community. This also corroborates with Hoggarth *et al.*, (1999). The article said that no single management tool would answer all the objectives of management. A combination of tools should thus be selected for each fishery management, as appropriate to the local situation.

The ultimate objective of community based management practice is aimed at ensuring the sustainability of the initiative. There are however, many interpretations, meanings regarding sustainability. According to Alam *et. al.*, (1997), a set of minimum conditions are needed for development to be sustainable: Increases in real income per capita; improvements in health and nutritional status; educational achievement; access to resources; a fairer distribution of income; and increases in basic freedoms. Redclift (1990) observed that sustainable development, is either about meeting human needs, maintaining economic growth or conserving natural capital, or about all three. It is further argued that there are different levels at which sustainability is important. These distinctions are important because what is sustainable at one level may not be sustainable at another and *vice versa*. One could argue building upon Redclift (1990), that Brundtland Commission's report 1987—Our Common Future, placed the emphasis in sustainable development in human needs rather than trade-offs between economic and biological systems.

Pomeroy and Williams (1994) pointed out that CBRM provides a sense of ownership over the resources, which makes the community far more responsible for long-term sustainability of resources. They further observed that the potential advantage of community based resource management include effectiveness and equity. CBRM can be more economical in terms of administration and enforcement than national, centralized systems where the community takes responsibility for monitoring and enforcement.

To be able to make the effort sustainable the community needs to be empowered and such process of empowerment must also be associated with the control of knowledge. As Cornwall (1992) has argued that all development work is to do with the control of knowledge, and if the underprivileged were able to control the sources of knowledge, the structures of existing power relations would be radically altered. Craig and Mayo (1994) observed that empowerment is about collective community, and ultimately class conscientization, to critically understand reality in order to use the power which even the

powerless do possess, so as to challenge the powerful and ultimately to transform that reality. Villarreal (1992) defined power as the capacity of an individual to impose his or her wishes or will on others. She noted power involves personal abilities and perspicacity to perceive edges and social interstices that can be taken advantage of social situations to establish control over the day-to-day life of individuals. According to Kaufman (1997) power can be thought of in many ways. It may be a positive connection with nature and the world around us; a fluid understanding of our capabilities, abilities and limitations; a sense of what we can achieve and how we can positively influence and live in harmony with the social and natural world around us. But Afsar (1998:) quoting Foucault argued that power is a mode of action upon actions, of power as productive, as intimately bound up with knowledge. And she noted that where there is power there is resistance.

Local people struggle with power processes and complexities in their daily lives. Power implies how hierarchies and hegemonic control demarcate social positions and opportunities, and restrict access to resources. Thus in order to achieve some control over their life circumstances local people must secure access to resources of various kinds. In addition to basic material conditions, they will also need to struggle and negotiate over authority, status and reputation. These dimensions crucially concern their agency often expressed through local organizational forms.

Social development as empowerment does not see people as deficient and needing external support; more positively, it seeks to create an interactive and sharing approach to development in which people's skills and knowledge are acknowledged. But as Rowlands (1997) has commented, empowerment takes time and it is not a process that necessarily achieves results in the short term.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Study areas

The study was conducted in two beels namely Hamil beel and Rajdhala beel and the community encompassing the beels. Hamil beel is located in Dhanbari union under Madhupur upazilla of Tangail district while Rajdhala beel is located in Purbadhala union of Purbadhala upazilla under Netrokona district. Geographically Hamil beel is situated in the north-central part of Bangladesh and lies between $24^{\circ}42'06''$ to $24^{\circ}42'22''$ N and $89^{\circ}57'18''$ to $89^{\circ}57'47''$ E. Rajdhala beel is in the northeastern part of the country and lies between $24^{\circ}56'40''$ to $24^{\circ}57'20''$ N and $90^{\circ}35'20''$ to $90^{\circ}36'05''$ E (Figure 3.1, 3.2 and 3.3).

3.2 Study period

The study was conducted in two consecutive years from March 1998 to April 2000. The study beels were perennial in nature. Therefore, beels were stocked seasonally but harvesting was periodic or partial. Sampling of all other parameters were done regularly and continued till the end of the study. It is to be noted that CBFM Phase I, funded by Ford Foundation was operational since 1996 and ended on 30 June 1998. Activities under this phase were implemented through a tripartite collaboration between GO-NGO-Fishers. Caritas under another grant from The Ford Foundation continued the activities up to 2001.

A significant part of the first phase of the project was dedicated to organize the fishers and familiarizing them with the aims and objective of the project. The concept was also new. Therefore, it was justified to select the study period in the subsequent years during the phase II (Caritas part) to investigate the outcome of Community Based Management effort pursued by the project. This gave an opportunity to critically see how the fishers acquainted themselves with the concept of the project approach in terms of fisheries management, sustainable use of resources, equity, building up community organization, and at the same time how effectively they applied those in their work.

3.3 Research design

The main purpose of the study was to develop a model for the management of beel fisheries for the community. Therefore, several issues related to socio-economic and physico-environmental aspects were taken into consideration for the study. The research is based on primary and secondary data sources. Interviews with potential users, key informants were undertaken. A questionnaire was developed to collect physico-chemical parameter data. PRA techniques were applied to collect qualitative data.

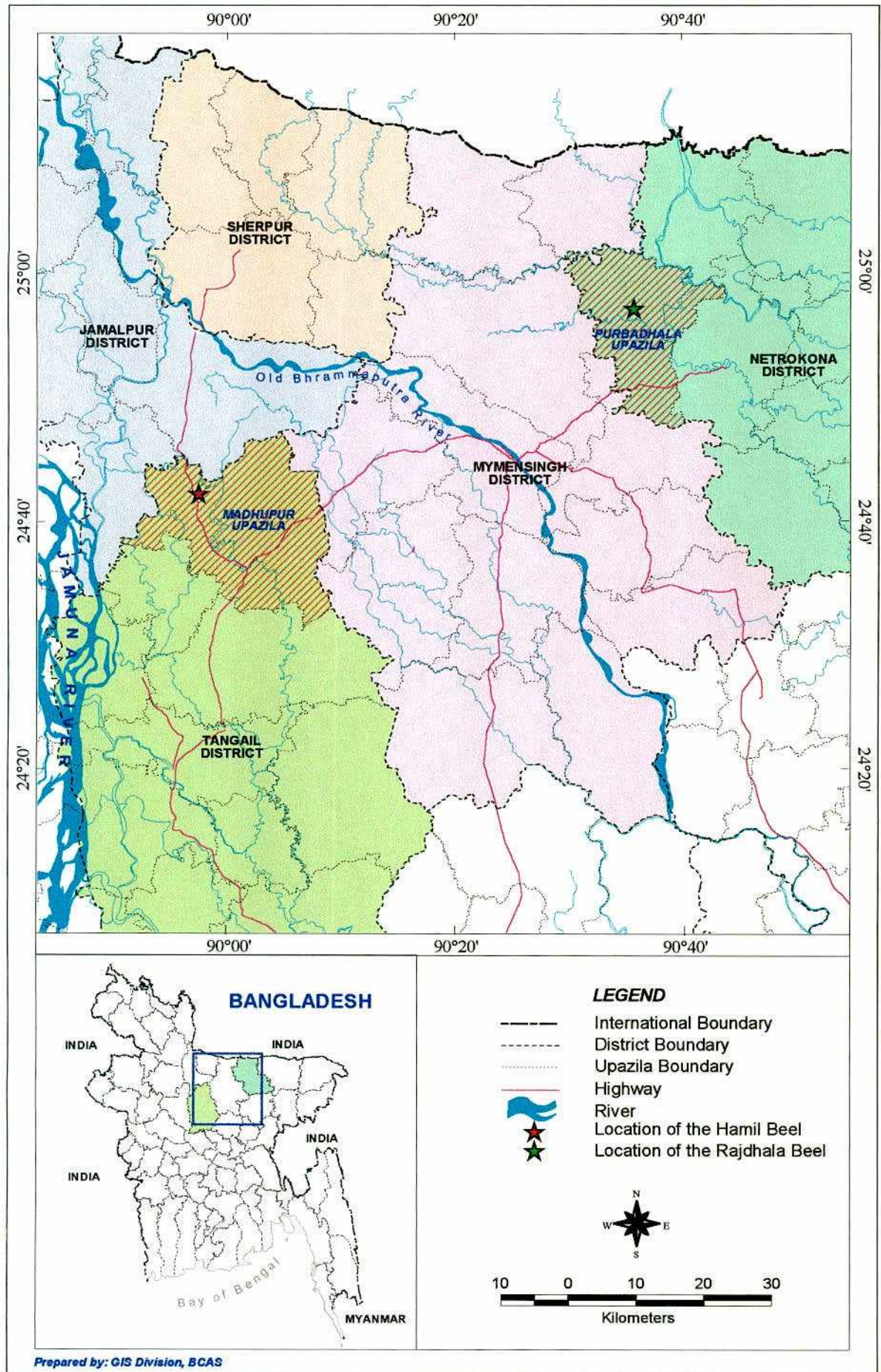


Figure 3.1: Location of Study Areas

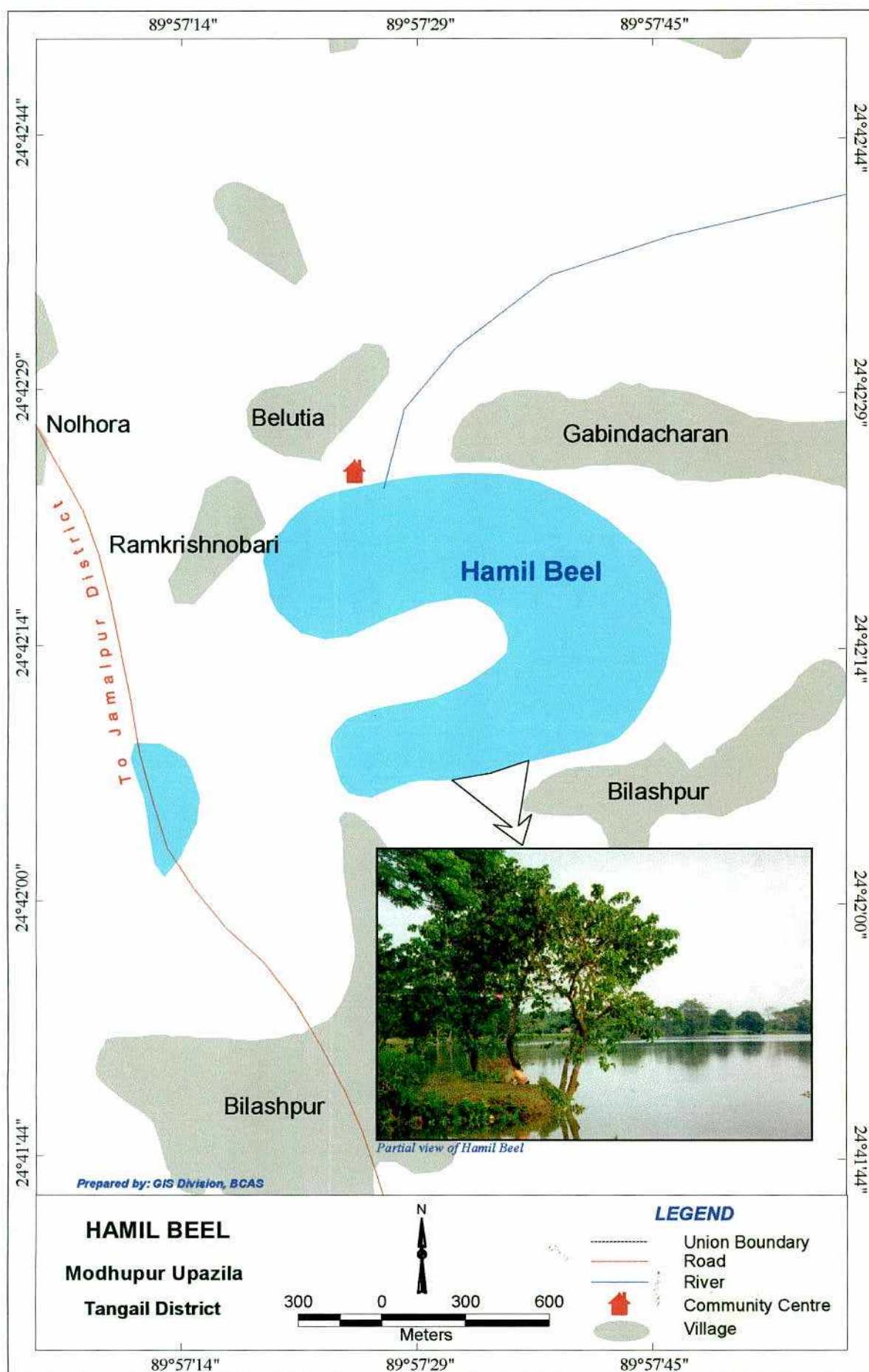


Figure 3.2: Location of the Hamil Beel

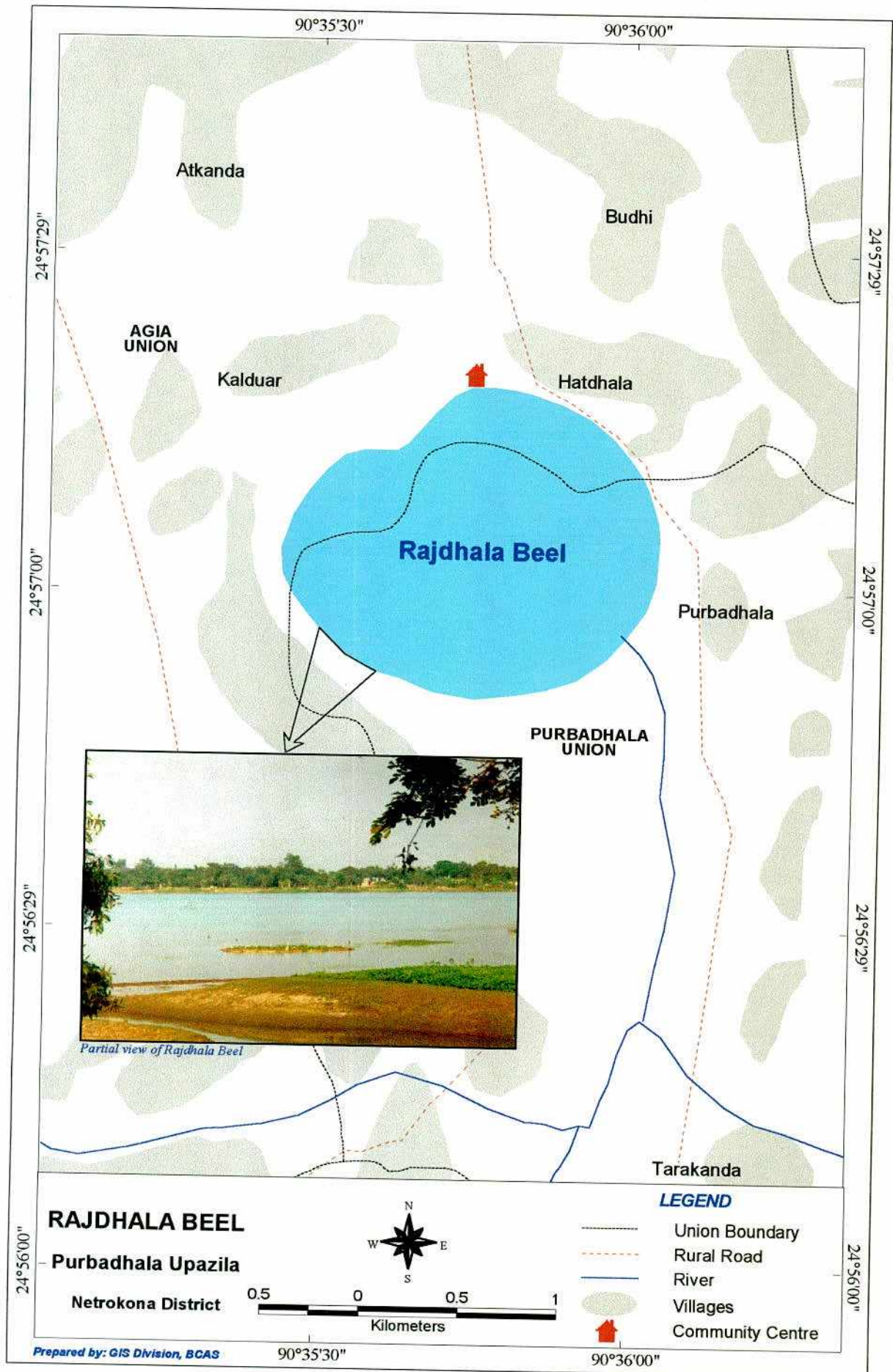


Figure 3.3: Location of the Rajdhala Beel

3.3.1 Secondary sources

All relevant data to describe the situation of the study areas were collected from the sources: Department of Statistics, Department of Agriculture, Department of Fisheries, and Bangladesh Center for Advanced Studies. Besides these, annual reports, documents of the working agencies in the areas were also consulted for better understanding of the status of the area.

3.3.2 Primary sources

Field work was conducted to understand the impacts of the community management of the beel fisheries including direct interviews with the users along with prepared questionnaire and direct observations. Many ideas and attitude of the users were also explored through these techniques. Focus Group Discussion with peer users, interview with key informants with the local level administration personnel was also made. Meeting minutes, resolutions, savings account, bank transaction books were also investigated to assess their performance.

3.4 Impact areas of the study

The major areas for the study were related with the development of human resources, capital resources, fish production and fisheries environment, etc. However, the several parameters were included for each area to study the impact of community participation and these were as follows:

3.4.1 Human capital study

Organizing the community

To be able to stick to the particular category of people, information was collected from the fishers list from DoF office, thana administration, local government offices and from the Fisheries Cooperative Societies. In addition, Focus Group Discussion (FGD) as well as Participatory Rural Appraisal (PRA) method was also carried out to make the selection of the group members. CBFM Project partners (GO, NGO, researchers) attended in the orientation workshops and PRAs. Discussion sessions were also held with respective Union Parishad Chairman and his associates to share the findings of previous discussions with other stakeholders as mentioned above and also to keep the local government apprised on the initiatives that will have been taken through CBFM.

Organizing the groups and activities

As discussed earlier identification of genuine beneficiaries were carried out through the application of some methods namely PRA, FGD. Once this was done and the community people were sufficiently appraised on the aims and objectives of the project, they were divided into groups following certain criteria such as their economic condition, occupation, education, age and the extent of their dependency on the resource. The group size has also been considered, as this is also an important for proper functioning of the groups. As per the plan of CBFM project first the fisher groups have been formed. Caritas maintained the notion that since the beneficiaries would be the prime stakeholders of the initiative their agreement to the process is most important. This has been the difficult part as most of the beneficiaries had gone through the phases where pledges have never fulfilled. Regular interactions with the groups associated with demonstrated willingness of the Field Workers, the beneficiaries had agreed to participate in the process.

Savings

Building up of own capital of the beneficiaries was thought to be an indispensable activity of the community organization. The beneficiaries have been adequately briefed on the necessity of building up their own capital. Immediately after the formation of the groups they started depositing savings. The groups on the basis of consensus fixed the rate of savings. Although there was a fixed rate of weekly deposit, the groups also kept the door opened for those who could deposit more, thus allowing flexibility in the system. The members deposited their savings during the group meetings. Developing savings habit by the groups had multiple purposes. First of all, through the process of building up their own capital, the sense of belongings was expected to increase and secondly, this capital accumulation process would also enhance their capacity to embark upon economic activities, either by the groups or by individual members.

Adult literacy

The enthusiasm of the beneficiaries was quite high and they were determined to make a change. But something else was needed. Adult Education has been perceived as “an educational system that produces self-discoverers and lifelong learners”. For CBFM beneficiaries it was not only necessary to attain basic numeracy and literacy skills to perform day-to-day work, but also to attain self-esteem and dignity. It was thought that through this informal teaching that is designed to make knowledge relevant and help individuals, families and communities to identify and solve their own problems. Providing Adult Literacy to the group members was part of the activities by Caritas under CBFM Project. In the group meetings decision was taken with regard to the selection of the

learners *vis a vis* the course. Special classes were then arranged keeping in mind the availability of the learners. The timing for the course was important, as most of the group members were busy during the daytime. Duration of each course was for 6 months using FIVDB curricula for Adult Education.

Training

Development and education are first of all about liberating people from that hold them back from a full human life. Ultimately development and education are about transforming society. Side by side with the other activities of the groups special emphasis was laid on developing the skills of the groups in various fields of development and prepares the group members to fight vulnerability. For the identification of the training needs and for the selection of participants for the trainings were decided in the group meetings.

The training program was designed looking at the aptitude of a member and also analyzing the need of the recipient. It made sure that each member receives some kinds of trainings depending on their ability. The training program was basically divided into two broad areas such as (a) General Awareness, that includes awareness building and motivation, women development, leadership development and (ii) Skill Development that included accounts keeping; resources management; fishery; poultry, kitchen gardening etc. Designing the training curricular was based on K.A.S (knowledge, attitude and skill) concept so that increased knowledge brings attitudinal changes and with the changed attitude the context of developing skill is created leading to better livelihood practice.

Exchange visit

Learning by seeing was the concept. As part of process to implement this component, the project maintained flow of information from other initiatives of similar nature taking place elsewhere in the country or abroad. First these findings were shared in the group meetings, community gatherings for stimulating the thinking process of the resource users. Then plans were devised to expose them to the actual situation. Arrangements were made with the organizations, projects to make a suitable time for such visits, taking into consideration the availability of the groups. Usually, such exposures were arranged during the lean period when the members could afford to take a few days off from their regular work. This was also done for the project staffs, as they would ultimately guide the group members in imitating the process.

3.4.2 Social capital study

Institution building – The Beel management committee (BMC)

From the conceptual stage of CBFM it was though imperative to build up an institution that would work continuously to look after the interest of the fisher groups and at the same



Plate 1: Meeting of beel management committee

time ensure sustainable management of the resources. The researcher also took the experience of Caritas in the formation of Apex organizations through the process of dialogue and interaction with the groups. The BMC was formed in both the beels during 1997. The composition of the BMC was done in democratic way so that each of the groups can put their representatives in the BMC.

Activities of BMCs are guided by a set of rules and roles and functions of the office bearers were in accordance with the procedures. After the formation of BMCs they started to develop fisheries management plan including, revenue collection, payment, guarding, harvesting to the arrangement of sharing cost and profits.

Local allies

It is widely perceived that development initiative, even if that is targeted for a particular section of a community must involve other group of people in the process. Supportive role of non-beneficiaries could add value to the initiative. In this premise a forum composing other members of the community was formed. These groups of people were convinced that the initiative would help the poor strata of their community.

3.4.3 Physical capital study

Community center

Both communities were involved in beel fisheries management. But there was no place for them where they can get together and discuss the problems. They would therefore meet in an open field, school premises, in the dyke of the beel to organize a discussion meeting.

There was even no place where fishers of CBFM could sit with the project partners. They were in want of a place not only for meeting but also to maintain an office where they could keep the document, files and other materials that are needed to run an office. They needed a place where they could keep their fishing net and other accessories. During the regular meetings the need for such a place would come under discussion.

Excavation and development of nursery pond

Due to scarcity of the availability of quality fingerlings, it became necessary to have nursery ponds. Since the beels are larger in size and the fingerling requirement is huge. This requires huge amount of money if fingerlings are brought from outside. Moreover, the timely availability of fingerlings, species composition and desired size is uncertain if dependency remains on outsider suppliers.

3.4.4 Financial capital study

Lease arrangement

Arrangement of lease was conducted in the traditional system, *i.e.*, lease year begins from the first day of Bengali year (mid April) and the highest bidder obtains lease. Both the study beels are Khas Jalmohals. The lease value that existed in the beels was decided by the Government, which was primarily seen as source of revenue earning. The biological characteristics *vis-a-vis* the productivity of the resource and the implication of the lease value on the livelihood of the resource users remain as a secondary priority. Under the auspices of CBFM both the beels were transferred to Ministry of Fisheries and Livestock (MoFL) from Ministry of Land (MoL) so that the beels could be brought under community management. The fisher groups obtained the lease through public auction by bidding the highest rate. It may be noted that proper documentation have been done regarding leasing time, lease value, lease money, arrangement for depositing the lease money etc. The researcher was actively involved in all the process and undertook extensive effort in rapport building with the concerned authorities in obtaining the lease arrangement for the community (Thompson *et. al.*, 1998).

Financial management for fisheries activities

This goes on to see what level of monetary involvement was necessary to ensure the financial management for fisheries. It was also important to see the return of such investments. The main areas of such expenses were in meeting access cost to the resource, purchasing fingerlings, carrying fingerlings to the beels, net/boat purchase, nursery raising, guarding, harvesting, marketing etc. There has also been a process to assess the return of

such investment at the end of each event. All these transactions were recorded in an orderly manner.

Income generation projects (IGP)

For resource management (enhancement and conservation) the beneficiaries had to follow a series of activities, which included closure period, compliance with fish acts. These initiatives compelled the fishers to stay away from fishing during the closure period.

Credit is an important aspect of CBFM. Credit support was provided to the project beneficiaries to reduce their dependency on moneylenders, compensate loss of income during any closed season as decided by the BMCs. At the nascent stage of the initiative and immediately after the formation of groups, the process of thrift savings started. The purpose was

- To build up savings habit as part of capital accumulation and
- To use the savings as collateral for taking loans for various types of Income generation projects.

It may be mentioned that such IGPs were seen as supplementary initiative in addition to the normal fishery related activities. To support their livelihood number of IGPs has been offered from the project. IGPs were of two types *i.e.*, fisheries and non-fisheries. Fisheries related IGPs included nursery raising, net purchase, boat purchase, fish processing, Non-fisheries related IGPs were poultry, livestock, kitchen gardening.

Mainly IGPs were offered to individuals. There were cases where IGPs were given to groups. The process that was followed for sanctioning loan for IGPs was that a proposal was placed in the group meetings. The process undergoes some stringent measures such as the experience of the applicant for the scheme he/s wishes to undertake, whether or not the applicant meets the condition of meeting at least 20% of the total investment from his/her own source (savings), if received training in the relevant field. All these were done to ensure that the proposed investment is risk free and the member is able to get good return out of the investment. While scrutinizing the application special attention has been given on the aspect of fisheries management (for fisheries related IGPs). For example, usage of current net or using pesticides in the fields adjacent to the beels were totally discouraged even if such schemes guarantees maximum profit. Therefore, precaution was applied in every possible area to keep a balance between livelihood development effort and sustainable use of resources.

3.4.5 Changes in fisheries management

The community looked upon management of fisheries resource in two distinctive ways viz. a) access to the resources and b) adoption of participatory management practice in the functioning of the BMC. Before the introduction of CBFM in both the beels there has been some form of fisheries management system especially in Hamil beel. The system was introduced and practiced by a group of individuals and hence the response of the community in general was not evidenced, as the latter did not have any say over the issue of resource management. The BMCs devised the protection and conservation measures and made it mandatory for all to comply with such measures. Being the lead organization for all the groups and also as the spokesmen for the community it was expected that everyone must comply with the system/rules promulgated by the BMCs. The members were made convinced that BMCs are made to look after the interest of the general members not only in the short term but also consider the long term perspective about resource management. For introducing proper management systems the BMCs meticulously looked after some essential prerequisites in the areas of stocking, guarding, harvesting/marketing plan, benefit distribution etc. These are summarized below:

Stocking

a) Preparation work for stocking

The beels were created about 200-300 years ago. Since then it has been used as public water body and resource was only the natural fishes. However, during eighties and afterwards, stocking practice was initiated but not in a scientific way. Since creation neither the beels never dried out naturally nor any initiatives taken for bailing out the water for management purposes. For the present study the stocking measures were taken for management purposes as pre-preparatory work.



b) Fingerling stocking

The larger species were completely harvested during the preparatory works. Few species of dominated small fishes along with other varieties having young age classes still remained as residue in the water bodies.

Plate 2: Stocking in Hamil beel

The representative data of such residual stocked was not possible to enumerate before the subsequent periods of harvesting. However, the beels were stocked properly with major compatible fish species. Major activities of stocking are narrated on the following points:

c) Procurement

The fingerlings were procured from various farms and nurseries owned by the public and private owners. The fingerlings of both sources were produced through induced breeding and reared in the nursery. The species of fingerlings were reared in a monoculture system. Therefore, it was possible to collect fingerlings of the required number and desired size.

Due to the large areas of beels it was necessary to stock the beels with huge number of fingerlings. It was not possible to stock the required fingerlings at a same time. So the stocking regimes were completed in various days.

d) Conditioning

Before transporting and as well as stocking, the system of conditioning was properly observed. In the collection centers they were caught before 2 - 3 hours of transport and stocked in hapas to allow time for conditioning and to make them strong enough to withstand the stress during transportation. At the study beels they were stocked in hapas for acclimatization. Counting are made and removed unhealthy and injured fingerlings.

e) Releasing

Before releasing initial length and weight of representative numbers (15-20) of each species were recorded. The length was recorded to nearest centimeter and the weight in grams. After proper count and recording the stocking hapas were then slowly lowered and tilted in to the beels, the fingerlings were allowed to swim into the beels freely. The way ensured only the healthy and strong fingerlings stocking.

Guarding system

This was a new and innovative concept that was introduced in the beels. Group members were motivated that they must make sure that their resources are protected from poachers. Although there has been some difference of opinion in the beginning but later the system was well established. Individual groups selected the members for guarding duty and BMC coordinated the work.

Harvesting and marketing plans

BMCs made specific rules for harvesting. This was important since the expectation of the fishers grew high, as they had to wait for a long time to see the result of their hard work throughout the period from stocking to harvesting. This is a vintage time for which everyone associated with the work. The responsibility of BMCs was therefore manifold. With the approach of harvest time each group was asked to send names of fishers from each group who would be engaged in harvesting. It was made sure that all the members extend their helping hand in this work. Simultaneously how to market the product was also thought upon. While they were knowledgeable about the existing marketing facilities they have decided to introduce a new system that is to sell the fish directly to the whole seller right at the bank of the beels. This way they avoided the middlemen and at the same time maintained complete transparency in the selling process. Usually all the fishers were present during the sale and BMC would make sure that the total transaction is made in front of the members so there remains no question about the dealing. All these transpire the impact of BMCs efficient handling of the events and also to respond to the feeling of the fisher community in general.

Benefit distribution and future investment provisions

After marketing the products, it was time to distribute the benefits to the members. As a matter of fact, the rest of the modalities have been decided well before the actual distribution of profit takes place. The net profit have been calculated considering all the expenses incurred in terms of input cost, management cost and other associated cost related to the production. As total transparency has been maintained and all the dealings were done in a systematic manner. There was hardly any suspicion or question on the net profit. At the end of the day's activities all dues have been settled. It was decided earlier that BMCs would retain a percentage from the net profit for future reinvestment. The rate was agreed to be 20% of the total profit on which all the group members agree upon. Initiating this system of retaining certain percentage from every cycle of production profit BMCs have been able to devise an inbuilt system of expanding their financial base, which would supplement their future undertakings.

3.4.6 Natural capital*Physico-chemical parameters of water*

The physical and chemical properties of water include temperature, depth, transparency, dissolve oxygen, free carbon dioxide, hardness, alkalinity, pH, ammonia, nitrate, etc. The physico-chemical qualities of water of the studied beels like temperature, depth,

transparency, pH, dissolve oxygen, free carbon dioxide, hardness, alkalinity, and nitrite were determined in the present investigation. Mostly the apparatus used for chemical properties was the HACH's universal aquaculture testing kit, Model No. FF-1A, USA.

a) Temperature

The degree and variation in temperature of water have great bearing upon productivity in general. The temperature was measured by a floating laboratory thermometer provided in the water testing kit box (Aquamerck-Germany). The value was recorded directly from the water by dipping a centigrade thermometer into the water body of the epilimnion area at littoral area and mid place of beels. The temperature was recorded weekly between 10 a.m. to 12 a.m. in the fixed sampling places.

b) Depth

Depth of a water body is an important factor bearing on physical and chemical qualities of water. The fluctuation water level as well as depth plays a vital role on the productivity of water. The depth of the beels from the surface of water was measured by sending weight attached with nylon rope of the bottom to the every specific station. The depth was categorized into low deep and deep water area of the beel from a boat and the value was recorded with a measurement tape in meter. At every case weekly measurement was noted down followed by monthly average.

c) Transparency

The level of transparency reveals the turbidity and density of planktonic organisms. It was determined weekly with the help of a Secchi disc of 20 cm diameter. Lowering the Secchi disc into the water until it just disappeared, then the range of transparency was calculated with the help of measuring tape in centimeter from the marked rope from which the disc was hanged. The sampling place was limited in the littoral zone and mid place of beels using a boat.

d) pH

The hydrogen-ion concentration (pH) is an important factor and variation of which, among other causes, are linked with the species composition and life processes of animal and plant communities inhabiting a beel ecosystem. The pH was determined weekly between 10 a.m. to 12 a.m. following color comparator method on the spot. One of the two samples was treated with wide range of pH indicator solution. The other non-treated sample was compared with the treated sample through a color disc in a color comparator.

b) Dissolved oxygen

Dissolved oxygen regulates the metabolic process of plants and animals and also serves as an indicator of water condition. Water sample was collected weekly from beels between 10 a.m. to 11 a.m. of the day and kept in plastic bottles for titration. These were carried to the field laboratory immediately and analyzed. The sample water was treated with dissolved oxygen 1 reagent and dissolved oxygen 2 reagents to form an orange brown precipitation. Dissolved oxygen 3 powder pillow was then added to develop a yellow color. The prepared sample was then titrated with sodium thiosulphate standard solution drop by drop. Concentration of DO would be directly proportional to the amount of titrant used.



Plate 3: Measuring water parameters

c) Free carbon dioxide

Periodically water samples were collected from beels between 10 a.m. to 12 a.m. of the day and kept in sampling plastic bottles for titration. These bottles were carried to the field laboratory immediately and analyzed. To determine carbon dioxide in water, the sample was titrated with standard sodium hydroxide to a phenolphthalein end point and at every case weekly treatment was followed.

d) Total hardness

Water sample was collected from beels and kept in plastic bottles for titration. These were carried to the field laboratory immediately and analyzed. The sample water was treated with buffer solution, Hardness 1 and ManVer (R) Hardness indicator solution, Hardness 2 to give a pink solution. Then titrant Reagent, Hardness 3 was added drop by drop until the solution color changes from pink to blue. The amount of titrant added is directly proportional to the concentration of the total hardness (as CaCO_3). Weekly sampling was performed.

e) Total alkalinity

Alkalinity is an important factor in pond productivity, because most of organisms thrive and proliferate in alkaline waters, though several live in acidic conditions too (Jhingran, 1980). Water samples were collected from the beels and kept in plastic bottles for titration. These were carried to the field laboratory immediately and analyzed. The values were achieved by titration method with phenolphthalein and Bromocresol Green-Methyl Red Powder pillow with sulfuric acid standard solution. Weekly treatment was conducted.

f) Ammonia

After a certain interval water sample was collected from beels and transferred to field laboratory and analyzed. Nessler Reagent ammonia test was done by a color comparator method. Rochelle salt was added to the sample to eliminate interference due to hardness.

g) Nitrite

The sample was treated with Nitri Ver (R) 3 Nitrite Reagent powder pillow and was compared with a no-treated sample against a color disc in a color comparator.

Biological parameters

Aquatic micro and macro vegetation, planktonic biomass and benthic organisms form the biological basis of beels productivity. In the present investigation, planktonic biomass and benthic organism were considered for study.

a) Plankton estimation

Free floating plant (phytoplankton) and animal (zooplankton) organisms are planktons, which imply the productivity of an aquatic ecosystem. In this research quantitative and qualitative account of the phytoplankton and zooplankton of the beels have been determined.

b) Collection

The samples of plankton were collected regularly from every selected station of the beels by a plankton net made of bolting silk of mesh size 0.025 micron, fixing a conical flask of 50 ml at the narrow end. For the quantitative estimation of plankton, 30 liters of sub-surface water (10 cm) below the surface was collected from various spots around each station by means of a 500 ml container and filtered through the plankton net. The

collection was always made between 10 a.m. to 11 a.m. The filtrated plankton was transferred to a 50-ml plastic bottle and preserved immediately in 5% formaline. These were labeled properly and carried to the laboratory for analyses.

c) Identification

The vials containing the preserved plankton were stirred gently for equalization in distribution from which one ml sub sample was drawn with a pipette into the Sedgwick Rafter counting cell. After three times identification of the same sample, the planktons were then averaged. The organisms in the S-R cell were counted randomly for any 50 out of 1000 units with the help of a compound microscope for quantitative study. The plankton of the original water was estimated by the given formula,

$$N = A \times C/L$$

where,

N = Number of plankton/l of original water

C = Volume of the concentrated water (ml)

L = Volume of the original water (litre)

A = Average number of plankton/ml of water

The phytoplankton was identified following Ward and Whipple (1959), Prescott (1964) and APHA (1976). The identification of zooplankton was followed by Mellanby (1965), Ward and Whipple (1959) and Tonapi (1980).

Benthic fauna

The community of organisms living on the bottom of a water body is called the benthos form a very important collection of food items of fishes, especially bottom feeders. About 60% of the total food items of fishes come from insect larvae (Habib *et. al.*, 1984; Ali *et. al.*, 1986). It is a collection of heterogeneous organisms. In view of this,



Plate 4: Collection of benthic fauna

benthic study both qualitative and quantitative was accomplished during the study.

a) Collection of benthic fauna

Benthic samples were collected monthly from three different places of each beel: shallow (0-1 m), medium deep (1-2 m) and deep (>2 m). Three replicate samples were collected from each depth. Sample collection usually done in the morning (9:00 am.). The nature of bottom was also noted. For convenience five sampling spot from each beel were marked with the help of bamboo poles to establish sampling site.

An Ekman-dredge covering an area of 225 cm² was used for sampling of bottom sediments using an anchored country boat. Content of dredge along with other materials caught were transferred to a bucket and taken to the shore for washing. Each sample was then washed through a series of standard brass sieves of mesh size 0.02, 0.92 and 2.0 mm. The benthic organisms remain on the sieves were collected under contrasting background of black and white by means of fine forceps and kept into separate vials containing 5% formaldehyde for preservation (Wetzel and Lickens, 1979).

b) Study and identification

For study the samples were kept for 48 hours in the laboratory to allow the animals to harden (Maitland and Heedspith, 1974). The preserved animals were then transferred to a petridish and washed with tap water to remove the remaining washable detritus and mud. Then the benthic organisms were separated and counted into different major taxonomic group by using magnifying glass. When needed the microscope was used. Identification was done after Chu (1949), Pennak (1953), Mallanby (1963), Needham and Needham (1966), Ward and Whipple (1959) and Brinkhurst (1971).

3.5 Statistical analysis

The obtained data were analyzed statistically using the MS Excel by means of computer (SAMSUNG 551s) at Caritas Fisheries Program. Relationships among plankton, benthos, physico-chemical properties of water and the production of fishes were carried out.

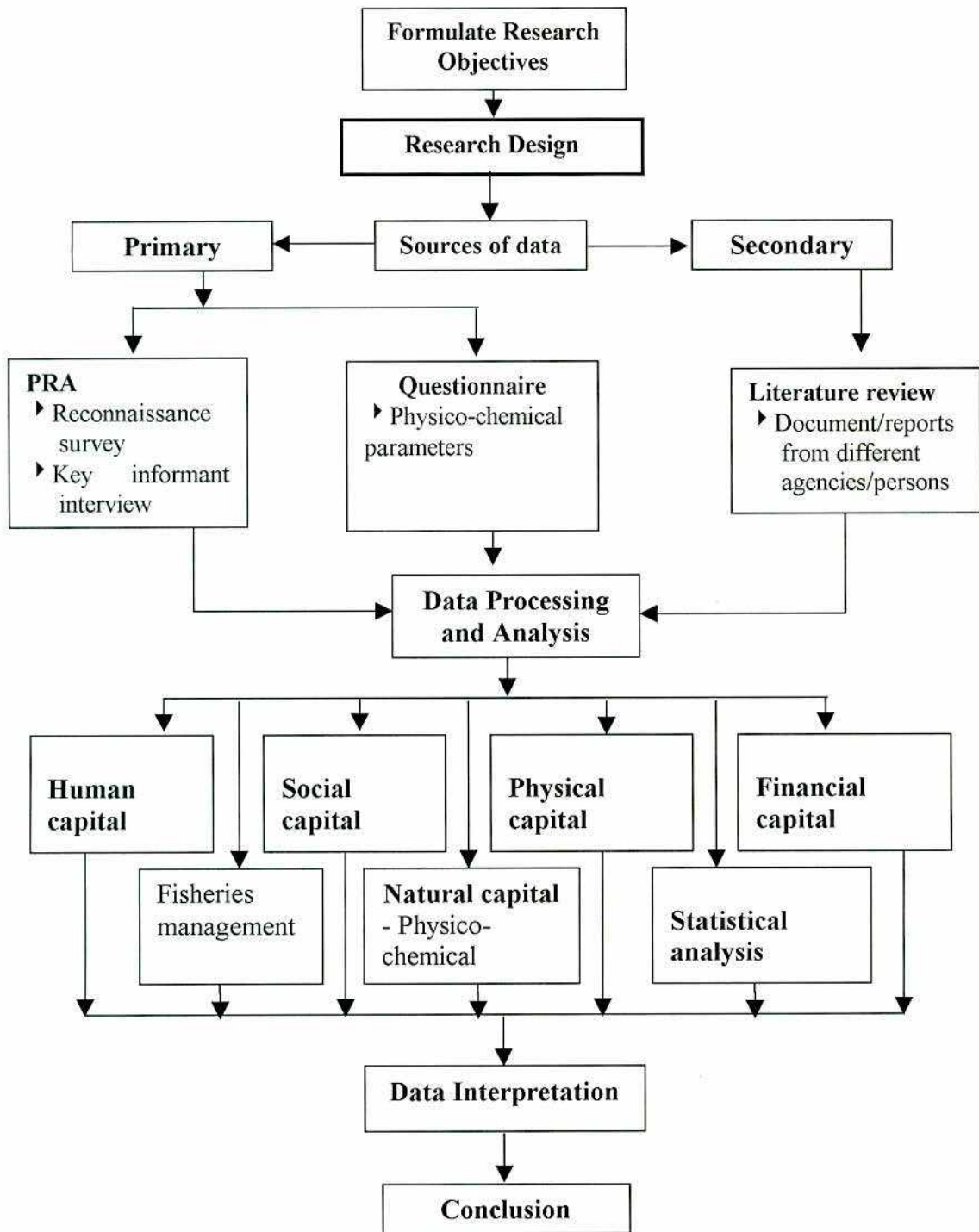


Figure 3.4: Methodological process of the research

CHAPTER 4

PROFILE OF THE STUDY AREAS

4.1 Location and physical characteristics

Hamil beel

Hamil is a native word meaning *coalesce* as the beel has developed from the confluence of two rivers (Bangshi and a tributary of the Jamuna). The river Bangshi was once flowing towards the southern part of the Mymensingh town. From the west a branch of the river Jamuna flowed towards the east and joined with Bangshi at the place adjacent to the village Bilashpur. In course of time the water flow of the two rivers has been shifted and with the closing of the confluence that created a waterbody about 200 year's back. The waterbody, since then, is locally known as Hamil beel.

Surrounding the beel, there are five villages inhabited by a variety of occupational groups including agro-farmers, sharecroppers, service holders, small traders and day labourers. Besides their usual occupation, they also derive an income from fishing in Hamil beel. The fishers of Hamil beel are Muslim by faith. They are first, second and in some cases third generation fishers. The majority is landless or has smallholdings.

Hamil beel is small semi-enclosed shallow but perennial lake located in Dhanbari union under Modhupur thana in Tangail district in north-central Bangladesh. The beel is horseshoe shaped and according to the record of the Ministry of Land (the area of the leased fishery) has an area of just under 40 acres (16 ha). It is one km in length and has a width of almost 500-meter. The water level barely falls below one meter even in the dry season. However, there was an exception in the years of 1986 and 1995 when this particular part of the country experienced severe drought. The beel has a small catchment area of adjacent fields and beyond these, homesteads and villages surround it for about half of its perimeter. On the west side there are low-lying fields and a road.

In the monsoon the beel is connected with the river Bangshi to the east through a small channel, and this is blocked by the fishers with bamboo fence to prevent fish from escaping. In high flood years such as in 1988 and 1995 the beel was connected with wider floodplains linked with the main Jamuna River and in such situation fish could move freely between beel and floodplains and river.

During the monsoon Hamil beel inundates the adjacent paddy lands and the waterbody stretches out. There is a small opening on the bank of the beel, which connects it with low-lying paddy fields. Fishers use net and bamboo screens in this opening to protect their

stock. During over flooding and heavy rain fishers used to trespass into those low lying paddy fields for want of catch, which breeds conflict between fishers and agri-farmers. There is a court order that no embankment can be constructed for separating the beel from the adjacent paddy field. On the other side of the beel, 10-12 ha of private lands becomes inundated during monsoon. Fish from the beel disperse out to the fields and the whole community catches fish. Low depth fields provides perfect environment for the indigenous fishes for breeding.

In the proximity of Hamil Beel there are a number of other small beels, which are mostly natural depressions. They are flooded during monsoon and come under cultivation during the dry season. There are two other beels that contain water throughout the year and are connected with the channels. The same people who fish in Hamil beel carry out unhindered fishing activity in all these water bodies

Rajdhala beel

Rajdhala beel is a semi-closed waterbody located in Purbadhala thana in Netrokona district of Bangladesh. The beel covers 53 ha and has two openings. It connects to a river (Dhala) about 0.3 km away to the north in the monsoon for a few months through a channel. The beel retains water all year round and in most places has a depth of 4.6m - 7.7m.

The word Rajdhala is derived by adding of two words Raj meaning *monarch* and Dhala meaning *white*. The beel originated around 300 years ago with the confluence of Dhalinodi, a branch of Kangsha river and Diarnodi, a branch of Brahmaputra. Both the rivers formed a junction at the center of Purbadhala upazilla - thus made a big natural depression. The depression then cutoff from the main river flow and formed a permanent beel.

The crystal clear water of the beel reflects sunlight during the daytime and in moonlight night the water looks spotless white and therefore, the word Dhala was derived from the whiteness of the water. The history says that during 1730 AD a king named Raja Sree Purva Chandas Sing settled in the area from Rajshahi in the Northwest part of the country. The king then brought the beel under his control and cherished the beauty of the waterbody for his leisure activities. The name Rajdhala therefore a blending of words Raja (King) to Raj and Dhala (White). It has also been said that the beel has been formed naturally by an earthquake. There are 4 villages around the beel with 640 households of which 93 households are traditional fishers.

4.2 Management of the beels – a historical perspective

Hamil beel

In Bangladesh *Jalmohals* were public (state) property since the East Bengal State Acquisition and Tenancy Act of 1950. Between 1958 and 1971 Department of Fisheries (DoF) held sole responsibility for the management of beels. The beel was leased out to individuals through open auction at a lease value of Tk. 200-300. From 1972 to 1987 the *beel* was leased to a cooperative society (Dhanbari Fisheries Cooperative Society) for Tk. 700 to 1200. Mr. Asimuddin was the key person in control of the resource at that time. He was the General Secretary of the society and was conversant with the laws concerning public lease holdings of Jalmohols. He also had connections with local leaders and elites. The ordinary members of the cooperative society did not show much interest in the management of the society possibly for fear of intimidation from the most powerful local people including the secretary. The interest of the ordinary fishers therefore was not served being the members of the cooperative.

In 1988 the beel was brought under a licensing system as part of New Fisheries Management Policy (NFMP). Mr. Asimuddin once again managed to be included in the Management Committee as President for much of this period, and effectively controlled the resources. Just before NFMP was introduced in the beel there were 141 cooperative members for Hamil beel but the number declined during the licensing period as non-fishers did not want to pay license fees. The lease value (paid through license) increased from Tk. 13,200 - 21,300 over this period, when there was a fixed 10% annual increment. The DoF supported stocking of the beel and further authorized stocking in the subsequent years. Caritas joined the Improved Management of Open Water Fisheries (IMOF) Project in 1992 and agreed to work in two water bodies for the development of local fishing communities. Hamil beel was one of these water bodies. There was no resource available to initiate the work and Caritas used its existing staff and resources for piloting the concept. This was done for only one-year period during which the following were achieved.

- Seven fishers group (141 identified licensed fishers) and three women's groups were organized.
- Collection of savings of Tk. 4,478 from 10 organized groups.
- Training courses on awareness building, leadership and group management, skill development and beel fishery management was organized.

Despite stocking in this period there were poor financial returns. The maximum production was 291 kg/ha was reported in 1990-91. After stocking the beel in 1995, a severe flood in the region took away all the stocked fish. Epizootic Ulcerative Syndrome (EUS) played

havoc with beel fish populations from 1988 and onwards. The situation was further worsened with the declaration by the then Prime Minister in 1995 that gave everyone the right and open access to fish in the open fisheries.

In 1995, Hamil beel was bought under Community Based Fisheries Management (CBFM) project. Caritas was also selected as one of the partner NGOs in this project and was responsible for supporting both the Government in implementing the project and the local fishing communities in adopting and introducing CBFM practices in Hamil beel and four other water bodies. In early 1996, the fishers were reorganized in six groups. A Beel Management Committee representing all six groups stocked Hamil beel in May 1996. Production under the reorganized community was much better in 1996 than in previous years and the returns were distributed equitably among the fishers. A new Beel Management Committee was elected in early 1997 and the beel was again stocked in 1997. Although there are some factional divisions among the fishers, general members have become aware of new management practices.

Rajdhala beel

Before the liberation war in 1971, fisheries were managed by Zamindars (feudal landlord) and later by DoF during the Pakistan period. There was less fishing pressure in the waterbody and fishers sometimes gave big carp and other wild fish to the Zamindars. It is reported that during 1960s the DoF released carp in the beel. Fisher leaders were responsible for guarding and other fishing activities. They did not catch small sized stocked fish and they would only get 25% of income from catching good size of carp and gave 75% of income to DoF. In the normal fishing time fishers used ber jal (seine net) and gave 50% share of catch to the DoF. About 100 fishers were engaged in fishing during the peak season at the same time they also owned agricultural land.

Many of the fisher families left Bangladesh during communal riots in 1965 or during the liberation war in 1971 and settled in India. After the independence of Bangladesh a Fisher Cooperative Society took the lease of this beel for three years. The cooperative society members totaling 72 fishers introduced fishing by five teams in a rotational system. They took 50% share of the income and they gave the rest to the cooperative leaders. Also they invested in four kathas (brush pile) from which the leader of the cooperative took 50% of catch. The fishers also gave a share of the catch of wild fishes to the cooperative leader. Seine net, moi jal and cast net were used during this period.

In 1981, Mr. Sunil Kumar took the lease of the beel through open auction from the district administration. Then in 1982, another non-fisher took this water body for two years at around five times the previous lease value. In this period only two teams with 22 listed

fishers fished during the peak harvesting time. In the other months all the fishers used seine net and cast net and gave 60% of the value of their catch to the leaseholder.

The lease value increased several times during 1982 to 1989 with changing hands between different leaseholders. In 1984, the fishers cooperative society's local leader managed the lease from the district administration but at a high lease value. Fishing continued to be done by two seine nets by 22 fishers during peak harvesting time giving 60% of catch to the leaders. Fishers were allowed to fish during the rest of the months and seine net users gave a lump sum share to the cooperative leader. The cooperative society's leader cum leaseholder got 60% share of income from catch.

In 1987, the fishers cooperative society took the lease again for 3 years with 25% increase over the previous lease value in the first year. In both the second and third years the lease money increased by 10%. The fishing arrangement was the same during this period, except there were 50 fishers who had access right for fishing. They also gave 60% share of catch to the representative of the cooperative society.

In 1990, the beel was transferred under the New Fisheries Management Policy (NFMP). The local fisheries cooperative leader, Mr. Adhar, was a member of the Central Matshyajibi Samabay Samity (National Fishermen's Association) and had good links with the district administration. He managed to fix the total revenue through license at Tk 20,000 per year (previous lease value Tk 52,937). Only 22 fishers got license and used four seine nets. They got 40% of the catch in the peak harvesting time (three months). Fishers gave 60% of the income from catch to the cooperative leader Mr. Adhar but a lower share of catch was given to him during the rest of the months. The lease value was paid from income earned through harvesting two kathas (brush piles) established by the fishers. The income from katha was shared as above. As the revenue was lower than before local influentials wanted to get this beel through open auction from the district administration. The Deputy Commissioner did not keep this waterbody under NFMP and instead auctioned the rights of the beel, although other water bodies under NFMP were still under licensing. Rajdhala was auctioned in 1992 to local influentials. Around 30 fishers operated four seine nets while all other fishers operated cast nets. The leaseholder also hired some fishers from other areas. In the next year another influential businessman from Netrokona district took the lease through open auction at a very high lease value. Local fishers reported to have said that the leaseholder could not make profit from the beel because there was not enough rain when wild fish should have come from the floodplain into the beel. Indiscriminate fishing was also reported during this year.

In 1995, Mr. Siddique Mia from Comilla district took lease of the waterbody for 3 years. The Department of Fisheries stocked five tons of fingerlings in the beel which were

supplied by the lessee from his own hatchery. Mr. Siddique Mia hired five local people and another five person from Comilla for guarding, caretaking and for overall management of the waterbody. He also appointed a local person as a manager to oversee the activities. The fishers gave 70% of the catch to the leaseholder, but subsistence fishing was not allowed.

Lease value was fixed at Tk 160,000 for the first year and the amount was same in the second year. Due to absence of the lease, the local manager started to cheat him by giving a lump sum rather than a share of catch and he did not show any account to the leaseholder. The manager and other caretakers faced regular quarrels with local fishers over rights for the poor to catch fish for subsistence.

When the project commenced, the beel was under control of an outside leaseholder. The local manager of the lease holder threatened the local fishers and warned them of dire consequences should they resort to fish in the beel. Some of the fishers brought this to the notice of the Thana Nirbahi Officer (TNO). Instead of taking punitive measures against those complain was made, two fishermen were taken into custody.

Mr. Awal, the manager, and his accomplice continued to intimidate the fishers and one night attacked some fishers when they were fishing in the beel. The fishers were so afraid that they barely came out of their home. The then Deputy Commissioner (DC) after being informed and appraised on the situation tried to find out a way out. In a letter to the Ministry of Land (MoL) the DC informed that the lease holder did not pay the lease money for the year. This paved the way to bring the water body under the control of DoF for CBFM project.

Due to strong non-cooperation by the organized fishers associated with growing differences with the manager, the leaseholder was forced to surrender his lease back to the district administration one-year prior to completion of his tenure. The DC as usual invited tender for further leasing out of the beel. Again, some other local influential persons tried to obtain the lease. In the meantime, DoF, through continuous persuasion was able to hold up the tendering process and the MoL asked for an evaluation report from the DC. Eventually in August 1997, following direct interaction with MoL and with supporting documents on the ongoing activities, briefing and lobbying from DoF, Caritas and ICLARM, MoL had decided to hand over the beel to MoFL.

The restrictions imposed by the leaseholders had resulted in conflicts in the community and in mid 1996 there had been a quarrel between the fishers linked with the leaseholder and some fishers organized by Caritas. The Thana administration had to intervene to diffuse the situation.

4.3 Biological characteristics of the beels

Hamil beel

During the 1960s, wide range of native fish species were found in Hamil beel and fishers recalled they were being caught in abundance. Nevertheless, connections with the river system became less regular through siltation and flood control measures and other infrastructure works. So gradual declining in fish stocks was reported, while the endemic major carps bore particular economic importance and was migratory in nature reported to be absent. In 1972, the beel was blessed with sound fish diversity along with a vast population size. After interview with the oldest BMC members as well as Thana Fisheries Office, the researcher identified 36 non-stocked indigenous fish (Table 5d, Annex-A). As the beel was under cooperative society, the beel have been often stocked with about four to seven kind of endemic major carps as well as Chinese carps. Among the non-stocked indigenous fish channids, cyprinids, belonids, clupids, bagrids, silurids, clarids, heteropneustids, tetradontids, mastacembelids, belonitids, leiognathids, gobiids, etc. were the dominant and commercially important fish. But in 1997, most of these fish were under threatened condition due to improper management.

Hamil beel has been stocked every year with fingerlings of native carps since 1972. The fry and fingerlings (about 2-5 cm in length) were purchased in boat load and were wild caught. From the NFMP (1988 and onwards) records have been kept of stocking and in the 1990s non-native carp species as well as native Indian Major Carps have been stocked from hatchery sources. These fish were then harvested in the post-monsoon to winter. The stocked species did not breed in Hamil beel.

Comparing the productivity achieved under community management organized by the Beel Management Committee with advice and supervision from Caritas in 1996-97 and with similar efforts organized by the Department of Fisheries and cooperative society during the NFMP period, production was over four times greater than the maximum reported for earlier stocking program even though the number of fingerlings was less. This reflected earlier stocking with larger fingerlings in 1996, a total production of 17.78 metric tones was achieved from stocking of 1.86 metric tones of fingerlings. The fishers believed that about 10% of stocked fish were left in the beel when harvesting ended.

A number of changes in the fishery are reported to have occurred. Natural events (disasters) are reported to be the main factors behind changing fish populations. Severe droughts in the 1985 and 1995 led to loss of resident beel species because very little water was left. The beel is semi-closed and there was only a limited opportunity for fish to re-establish themselves naturally - through the small connecting channel or with wild caught

fry and fingerlings stocked by the fishers. The fishers deliberately restored some fish after these two droughts. Chapila (*Gudusia chapra*), which was an important species in the beel, caught in large shoals and which very quickly dies when it is caught. Gozi (*Aorichthys* sp.) were carried from nearby waters in a mixture of 50% water and 50% milk to be released in Hamil beel.

After the 1985 drought, fish population had not recovered and the flood in 1988 caused loss of stocked species and inflow of wild species. But a serious fish disease (epizootic ulcerative syndrome) reportedly reached the beel during this flood and thereafter affected natural and stocked fish species. Aquatic plants also increased after the 1988 flood. During 1991 to 1994 the fishers gradually cleared water hyacinth and other aquatic vegetation from the beel and it was reported that this coincided with major increase in Chapila (which again disappeared during 1995 drought). Yet loss of fringing trees, aquatic vegetation trees and aquatic vegetation for cultivation may have adversely affected natural fish stocks.

Rajdhala beel

The traditional fisher households living around the beel are involved in fishing activities. However, some of their family members are also engaged in other income generating activities. There are 93 fisher households organized by Caritas and they fish in groups by rotation. Some of their household members are involved in fishing in other water bodies in the area. As fish catch declined overtime fishers have increased their fishing effort.

Fishers said that they mainly used cast net up to 1990 and their catch per unit has declined to about 3 kg/day from open beels/floodplains. The catch has been lower for the last five years, which was around 2 kg per day from same level of fishing effort. After handing over this beel to the community under CBFM they stocked the beel and have introduced management rules for effective fishery management.

The fishers can eat fish on average four days in a week. During the dry season when some of them fish in other open water bodies they eat fish on only two days in a week and sometimes they buy dried fish from local markets. The fishers set a restriction on fishing for two months (Chaitra-Baishakh) after stocking in 1997, as this was the breeding time for Chapila. Due to scarcity of job during these months they had to suffer from food insufficiency.

According to fisheries biologist the quality of water in the beel is suitable for fish culture. Although the beel under culture, wild fish contributed a considerable amount of income from catch. The beel has been endowed with a number of 34 non-stocked indigenous fish species since 1972 (Table 5d, Annex-A). Among the non-stocked indigenous fish

channids, cyprinids, belonids, clupids, bagrids, silurids, clarids, heteropneustids, tetradontids, mastacembelids, belonitids, leiognathids, gobiids, etc. were the dominant and commercially important fish. But in 1997, most of these fish were under threatening condition due to improper management. Among the stocked fish catla, rohu, mrigal, and kalbasu under endemic carps; silver carp, grass carp, common carp, and silver barb under Chinese carp were prominent.

The fish species reportedly unavailable were wrestling halfbeak (*Dermogenys pussilis*), Indian chaka, (*Chaca chaca*), mottled nandus (*Nandus nandus*), gulsha (*Mystus bleekeri*), and pabda catfish (*Ompok pabda*). The reason for unavailability of these species is due to overfishing, siltation in the connecting channels and natural events, e.g., flood and drought. The other wild species being endangered were: striped gourami, (*Colisa* sp.), mola carplet (*Amblypharyngodon mola*), Ayr (*Mystus aor*), Chital (*Notopterus chitala*) etc. It is noted that a natural species Indian river shade (*Gudusia chapra*), which was most abundant in the beel in the past has been declining for the last few years.

4.4 Stakeholders of the beels

Hamil beel

Before the cooperative society was established, the principal stakeholder was the leaseholder, Mr. Monsur Hazi, who was a non-resident. He contracted traditional fishers from Kalibari in Jamalpur District (20 km. north of the beel) to come once a year to harvest in the Beel. Since the cooperative society has maintained rights over the Beel for the past 25 years the previous stakeholder have long ago gave up his involvement in the Beel fishery.

In 1972, Mr. Hanif Sarker, a worker in a government office who lived near Hamil beel, formed the cooperative society. There were about 50 members of whom 27 came from Hamil Beel area. Despite his initiative, Mr. Asimuddin in the following year gained control of the cooperative since he was more literate and were able to deal with the government officials. Moreover, his sister married that year to Hanif Sarker's son. Although there were rules that the general secretary of the cooperative society should change each year, Asimuddin managed the government officials who agreed to his being selected each year. He arranged stocking and provided credit to finance this effort. He also arranged the guarding of the beel and harvesting of the fish each year. The general members were paid a daily wage of Tk. 50-60 at the end of this system in mid 1990s, which they believe was about 20% of the gross value of fish harvested. It was reported that during this period Asimuddin's sole income source was from these fisheries.

When NFMP was introduced there was little change in the status of stakeholders for 2-3 years but there were changes among those representing the fishers. But this again settled down with Asimuddin as president and Abul Hossain as secretary. Although DoF introduced a licensing system during this period, it did not actually issue licenses individually. Instead it worked through the traditional representatives or leaders of the fishers. The main change was that gradually the number of participants declined as non-fishers refused to pay for a license (since the leaders had managed all accounts including the lease costs previously). Thus in 1973 the cooperative had 76 members and by 1985 it had gone down to 41. In 1987 there were 153 licensed fishers in Hamil beel but it fell to 109 in 1988, 103 in 1990, and 69 in 1995. This trend was more or less brought into order in 1996 by Caritas by bringing those households that were involved in fishery and by involving those who were organized in groups.

The prime stakeholders in Hamil beel are now the organized fishers who are the group members organized by Caritas and who share equally the costs and returns from the beel (lease fee, gear costs, harvesting of stocked and natural fish using shared gear). These households have for the most part held this position for 20 or more years but prior to the CBFM project did not share so equally the management cost of the initiative. There are six groups and the fishers involved live in 5 villages around the beel. The villages are Nolder, Ramkrishnabari, Belutia, Gobindarcharan and Bilashpur.

Other stakeholders from the local community fall into three categories according to the resource they claim (fish, water and land). About 80% of the other households living in the 5 villages around the beel catch fish some time in a year, mostly for food. They are generally excluded from fishing in the beel, but some times a few them catch non-stocked native fish. Landowners living around the beel cultivate paddy in adjacent fields and pump water for irrigation. Hence irrigation brings down the water level and threatens the aquatic life. So far there is no forum for reaching to any kind of agreement over sharing of water. A persisting problem is the conflict between fishers and people who have taken land for cultivation inside the Beel on lease from the government. The water area is reducing due to gradual siltation and conversion to paddy cultivation. During the monsoon when paddy fields inside the beel are flooded, leases of the land start catching fish without the consent of the Beel Management Committee. In addition, the lessee of land has built bunds around their fields and catches fish as the water recedes. The fisher took assistance from the administration and police in 1996 to minimize attempts by these farmers to catch fish in the Beel.

The two main stakeholders from outside the local community are the DoF and Caritas. During the previous NFMP and IMOF project (1986-1995) under which Hamil Beel fell, DoF licensed the fishers and arranged stocking. This process helped develop good

relationship between DoF officials and the Fishers. At the end of this period Caritas started working with the fishers but lacked resources. During this period the role of DoF and Caritas have also changed. While Caritas field staff (of other Caritas Project) started working closely with the fishing community for their capacity building in organizational development and stocking, the role of DoF have been shifted to that of providing support in other areas.

Rajdhala beel

In the early 1960s Department of Fisheries (DoF) released carp fingerlings in Rajdhala beel. Fisher leaders were responsible for guarding and all other fishing activities. They did not catch small sized stocked fish and they would only get 25% of income from catching good size of carp and gave 75% of income to DoF. Fisher representatives also occasionally distributed big fish to the influential, officials, etc. About 100 fishers were engaged in fishing during the peak season.

In the late 1960s, the beel was under Bangladesh Fisheries Cooperative Society where Mr. Adhar Das, a local influential, played a role over the beel and availed the maximum benefit. Sometimes he distributed big fishes to Landlord (Zaminder) of Purbadhala, as they were more influential. Before the liberation war (1971) the beel had been controlled by Mr. Bibhutibhuson Singh, Zaminder of Purbadhala for a few years. After the independence of Bangladesh a Fisher Cooperative Society took the lease to this beel for three years (1971-73) against the lease money Tk. 60,000 per year. The cooperative society had 72 fisher members conducted fishing by five teams following a rotational system. They took 50% share of income and they gave the rest share to the cooperative leaders. They could not run well and then the beel was given lease to a local person for three years (1973-75) against higher lease value.

In 1981, Mr. Sunil Kumar took lease through open auction from the district administration. Then in 1982 another non-fisher took this water body for two years at around five times the previous value. In this period only two teams with 22 listed fishes fished during the peak harvesting time and gave 60% of the value of their catch to the leaseholder. The lease value increased several times during 1982 to 1989 with changing hands between different leaseholders. In 1984 the fishers cooperative society's local leader managed the lease from the district administration but at a high lease value. In 1987 the fishers cooperative society took the lease again for three years with a 25% increase over the previous lease value in the first year, which was subsequently increased by 10% in the second and third year.

In 1990 the beel was transferred under the New Fisheries Management Policy (NFMP). The local fisheries cooperative leader Mr. Adhar was a member of the Central Matshyajibi

Samabay Samity. He managed to fix the total revenue through license at Tk 20,000 per year (previous lease value Tk 52,937). Only 22 fishers got license and fished. They got 40% of the catch in the peak harvesting time (three months). Fishers gave 60% of the income from catch to the cooperative leader, but a lower share of catch was given to him during the rest of the months. The lease value was paid from income earned through harvesting two kathas established by fishers.

As the revenue was lower than before, local influentials wanted to get this beel through open auction from the district authority. The Deputy Commissioner did not keep this waterbody under NFMP and instead auction the rights of the beel. Consequently Rajdhala beel was auctioned and leased to Mr. Aftab Uddin, of Purbadhala Thana for 1992-94 against lease value Tk. 60,000/- per year. Mr. Uddin surrendered the beel in 1993, as he too could not make any profit. Afterwards, Mr. Nayan Datta, from Netrokona district took the lease through open auction at a very high lease value (Tk. 75,000/year) for 1994-1996. He continued for only one year, 1994. It was reported that this leaseholder could not make a profit from the beel owing to inadequate rainfall at rainy season, for which wild fish could not come from the floodplain/river into the beel resulting a low fish yield.

In 1995, Mr. Siddique Chowdhury from Comilla district took lease of the waterbody from Govt. for three years (1995-97) in condition that DoF provided total five tons of fingerlings for stocking. But he had to pay lease value Tk. 160,000/year. The lease holder hired some local fishers also from Comilla for guarding, looking after and overall management of the waterbody. The fishers gave 70% of the catch to the leaseholder, but subsistence fishing was not allowed. Mr. Chowdhury surrendered the beel in the very early 1997.

The prime stakeholders in Rajdhala beel are now the organized fishers who are the members of groups organized by Caritas and who share equally the costs and returns from the Beel (lease fee, gear costs, harvesting of stocked and natural fish using shared gear). There are six fisher groups (Fishers-4, members-84 and Women-2, members-37) and the fishers involved live in 3 villages around the beel. Major three villages namely Hatdhala, Kaldoar, and Purbadhala surround the beel. There are three groups (Fishers-2, Women-1) in Hatdhala, one (Fisher only) in Kaldoar and two (Fisher-1, Women-1) in Purbadhala.

Like Hamil beel, other stakeholders from the local community also fall into three categories in consonance with the occupation. Around 75% of other households living in the surrounding villages also fish in the beel but for consumption purpose. The situation is similar to that of Hamil beel as these people often catch non-stocked native fish from the beel. Besides the community, other stakeholders are composed of DoF and Caritas. However, the role of each stakeholder is precise and distinct in its own term and clear demarcation of roles and responsibilities have been clearly defined.

CHAPTER 5

OBSERVATION AND RESULTS

5.1 Changes in human capital

5.1.1 Process of organizing the community

By maintaining total transparency on the process it was possible from the very beginning of the project to make an impression on the aims and objectives of the project. The process that was followed was able to convince communities that the initiative of community management of the resources would benefit them and at the same time would also ensure the sustainability of the initiative. Table 5.1 depicts the activities carried out for community mobilization.

Table 5.1: Activities for community mobilization

Activity	Beels		Number of participants		Remarks
	Hamil	Raj	Hamil	Raj	
Community meeting	4	4	125	153	Larger gathering for discussing the aims and objectives.
Household visit	35	64	-	-	Rapport building
PRA	2	2	65	72	Identification of beneficiaries.
FGD	3	3	85	95	Consensus on project area mapping and setting up groups.
Meeting with local govt. officials.	3	4	-	-	Local administration showed keen interest to support the initiative of CBFM Project.
Coordination with respective district administration	2	2	-	-	Clarification of project objectives and also to understand prevailing govt. policy on the resources.

As a result of those activities it was possible to (a) rapport building with the community people (b) confidence building measures with other members of the local community who would not be the direct beneficiaries (c) make the stakeholders fully aware of the aims and objectives of the project (d) identify genuine fishermen, who would be the direct beneficiaries of the initiative and (e) create an enabling environment for smooth launching of the initiative.

5.1.2 Organizing the groups and activities

A total of 6 fisher groups with 141 members in Hamil Beel and in Rajdhala beel 4 fisher groups with 94 members were organized during 2000. All households depending on fishing in the beels and those living nearby the beels have been included in the groups. To supplement the activities and to bring women in the centerfold of the development initiative 2 women groups in Hamil beel with 44 members and another 2 in Rajdhala beel with 37 members were also organized during 2000. The researcher was actively involved during the process of the selection of the group members and during the actual formation of groups (Plate a, Annex-C).

After the formation, the groups carried out certain activities. It was decided that all the groups should function according to the by-laws and would run their activities on the basis of consensus. The total groups organized during the course of the project are shown in Table 5.2.

Table 5.2: Status of organized groups

Particulars	1997		1998		1999		2000	
	H	R	H	R	H	R	H	R
Groups	8	4	8	6	8	6	8	6
Fishers	6	4	6	4	6	4	6	4
Women	2	-	2	2	2	2	2	2
Members	180	89	171	124	176	124	185	131
Fisher	142	89	136	93	141	93	141	94
Women	38	-	35	31	35	31	44	37

H- Hamil beel, R- Rajdhala beel

5.1.3 Accumulation of savings

Savings brought about a new impetus to the functioning of the groups. Sense of economic gain popped up and it was observed that because of the savings the activities of group gained new momentum. As stated earlier, savings collection would take place during the group meetings. This prompted the members to come regularly in the meetings as most of them did not want to become a defaulter as this might make it difficult to take loans for IGP's at a later stage. In addition to the capital build up, the most important aspect was the development of savings habit.

Table 5a (Annex-A), depicts the total savings accumulated by the fisher groups up to March 2000 was Tk. 100,170 at Hamil Beel and Tk. 89, 420 at Rajdhala beel. Savings by Women groups in Hamil beel were Tk. 19,800 and Tk. 15,900 in Rajdhala beel. The highest group savings has been recorded in Hatdhala Shapla MPS at Rajdhala, which was Tk. 23,550 and the lowest was in Rupali Matshajibi Purush Samity at Hamil beel. A highest saving was generated by Jamuna Mahila Samity at Hamil beel (Tk. 14,185) and Bilaspur Mahila Samity with Tk. 6,705 recorded the lowest.

5.1.4 Adult literacy

Table 5.3 details the result of adult literacy courses on various aspects. It can be ascertained that commendable progress was made in terms of their learning. From the percentage of attendance it became obvious that their keenness in acquiring the basics of learning have been greatly valued.

Table 5.3 Status of adult literacy course

Particulars	Hamil beel		Rajdhala beel	
	F	W	F	W
Teachers Training	4	1	4	2
No. of Course	4	1	4	2
No. of Participants	80	20	80	24
No. of dropouts	2	-	4	3
Read and write	44	10	32	8
Read and sign	57	12	42	11
Only can sign	61	14	45	19

F- Fisher group, W- Women group

The groups knew that to be able to manage their own affairs, there is no substitute than to have confidence on their own ability. From participating the adult literacy course the members were able to understand that although literacy may only be a part but still an essential element of the range of basic services, which bring direct economic returns as well as direct social benefits. After comparison of these achievements with the base line data it was observed that laudable improvement has taken place in the field of providing basic literacy and numeracy course. As discussed before the group portfolios were expected to carry out specific functions *i.e.*, the secretary is to take and write group resolutions and the cashier is to keep records of all account related transactions. It was therefore important for the members to enroll themselves in the

adult literacy courses to build up their capacity to take future leadership either within the groups or in the BMCs.

5.1.5 Training

Training was an important area of the intervention. This is a tool for capacity building process. Field of trainings was determined on the basis of the need of the beneficiaries in view of their future endeavor in resource management. Trainings were given in the field of awareness building, leadership and management, accounts keeping, women development, professional skill development, poultry/livestock/kitchen gardening and follow-up. It may therefore be seen that the training courses were basically arranged in two broad areas *i.e.*, on general awareness and livelihood development. It would be seen from Table 5.4 that 91.6% of the members have been trained in skill development followed by 90.8% in awareness raising.

Table 5.4: Status of beneficiaries training

Name of the Training	Courses		Participants		Percentage	
	H	R	H	R	H	R
Awareness build up	5	4	150	119	86.2	90.8
Leadership and management	5	4	148	110	85.1	84
Women development	4	3	123	60	70.7	45.8
Accounts keeping	5	3	110	76	63.2	58
Professional skill development	12	4	104	120	59.8	91.6
Poultry/livestock/kitchen garden	3	3	42	46	24.1	35.1
Follow-up	5	3	120	95	69	72.5

H- Hamil beel, R- Rajdhala beel

On the contrary, only 35.1% received training on poultry, livestock, kitchen gardening and 45.8% on women development. There was also a provision of follow-up programs, which have been availed by 72% of the trainees.

5.1.6 Exchange visit

During the planning process of CBFM, this component of the program was given due priority. The reason for retaining this provision in the activity plan is for the fact that by learning from the experience of others there remains a scope to incorporate some ideas. However, it is also common that in most development agencies these types of visit programs are arranged for the

staff. But in this case, preferential option has been opted for the group members, as they would be the key actors in the conservation and management of the resources. Exposure program was arranged to the project site of Banchte Sekha, another CBFM Project partner. Oxbow Lake Project (OLP), a DoF implemented project was also an interesting area of learning for the members. The project staff by participating in various training, seminars; exposures in both national and international level brought about new ideas that have been disseminated in the project. At the same time experience of CBFM (Hamil beel case study) has also been shared in many national and international forums. Table 5b (Annex-A) would give a glimpse on the nature of activities carried out in this field.

5.2 Changes in social capital

5.2.1 Institution building – Beel management committee (BMC)

Activities of BMCs are guided by a set of rules and functions of the office bearers are in accordance with the procedures. After the formation, the BMCs, among other organizational activities, began to develop fisheries management plan including, revenue collection, payment, guarding, harvesting and the arrangement of sharing cost and profits. The feature of the BMCs were that they had annual work plan which incorporated resource protection, fingerlings purchase, coordinate harvesting and guarding activities, usage and maintenance of community centers, contact with government agencies, payment of lease fee, revenue collection and supervise benefit distribution. It was also expected that BMCs would undertake other social activities in support to the need of the communities.

With regard to fisheries management, the BMCs formulated some rules as under:

- Only members of the organized community who pay government revenue and stocking cost can share in harvest
- Formal ban on fishing by non-members
- Formal closed season on fishing for stocked fish
- Formal acceptance of casual fishing for food for non-stock species
- Equal share in guarding duty and harvesting work among members

Besides implementing the planned activities by the groups such as beel management and livelihood development, special initiative has been taken to further develop the social and environmental condition of the community. Caritas distributed food and foodstuffs after the flood of 1998. Low cost housing was given to the most vulnerable group members. At the later

stage and under the professional rehabilitation program, support was given for reexcavation of ponds. All the above works have been coordinated by the BMCs. These were done not only to benefit the groups directly but also to make them responsible towards others as it was expected that the beneficiaries would provide the same support to those who are not involved in the project. The BMCs also came forward to respond to the need of some individual members of the community. These ranged from buying medicine for an ailing daughter of a member to meet funeral costs and arrange marriage. It may be noted that all these assistance came in the form of financial support, which have been met from BMCs own fund.

5.2.2 Local allies

The process of rapport building brought about attitudinal change. The local allies played their roles very effectively in bridging the gaps that once existed between the resource users and other members of the community. Through the intervention of the local allies the cooperation and coordination also heightened between the resource users and local administration. The Union Parishad Chairman, who never bothered to talk to these group of people, as they represent the lower strata of the society, took every opportunity to visit these group of people and listened patiently to their needs. Attitudinal change has also been observed. Previously the TNO and DFO, limited their visits up to the resource level only. But from then, they started to go to the user level. It was also encouraging to see that for the first time planning meetings were held in the community centers built by the fishers.

5.3 Changes in physical capital

5.3.1 Community center

With the continuation of the activities it was felt that the groups as well the BMC need a center from where they can coordinate their activities. The center shall serve as the nerve center of the initiative. With the growing need for such place and with no resources available to build the center, the fishers, from their own sources brought 8 decimal of land and with the help of Caritas two community centers were built. The centers then became the pivot of the activities (Plate c, Annex-C). It was a place where the meetings took place and all the activities of BMC was carried out. During the periods of 1998-1999, 1999-2000 all BMC meetings were held in the community centers. The centers were also used for conducting training's offered by the project. Project visitors from various agencies/organizations from both home and abroad held meetings in the centers. It was also used for keeping their fishing gears and accessories. The centers became the center focus of all activities of the community.

The fishers of Rajdhala beel also bought 10 decimal land (0.04 hectare) at a cost Tk. 6,500 where they have built the community center. Total construction cost was Tk.77,977 of which fishers contributed was Tk.35,977. Caritas contributed the remaining part as a grant.

5.3.2 Development of nursery pond

In Hamil beel in 1997-98, 10 decimal of land has been purchased adjacent to the beel. During the monsoon period the groups made a pen there and raised fingerlings, which helped them in minimizing the stocking cost. In case of Rajdhala beel, two ponds were taken on lease for raising fingerlings. This was in addition to the purchase of 10 decimal of land by the community, which was re-excavated for nursery raising for the identical purpose. Rajdhala, being a big beel, needed huge quantity of fingerlings and money if the fishers were to purchase those from outside sources. So, they were planning how they could minimize the stocking cost.

In 1999, they reared fingerlings in their leased nursery pond. They learned another technique that was to produce spawn from the brood fish of the beel. The fishers harvested 24 brood of Common Carp and placed them in the pond. Eight of the fishes were injected with Pituitary Gland (PG) during February 1999 and reared those in their two leased in ponds using Hapa of 10'x15'x3' size. After reaching the size of fingerlings they released the fingerlings into the beel. This is one example of innovation by the fishers of Rajdhala beel, which was also observed in Hamil beel. They became skilled in the process and were also able to minimize the cost of stocking.

5.4 Changes in financial capital

5.4.1 Lease arrangement

In 1997-98 the lease fee of Hamil beel was Tk. 29,288 (Tk.1,830/ha) and in Rajdhala beel lease fee was Tk. 20,600 (Tk. 3,887/ha) which was more than double of the fee of Hamil. Lease fee of Rajdhala beel is too high compared to the other public water bodies. From 1990 onwards Rajdhala was leased out to different persons at inflated price and as a result, none of the lessee could make any profit. The leasing system at Hamil beel however was steady as the process was streamlined before the beel was brought under CBFM. Present system of revenue collection shows that beels are leased out for a period of 3 years with an increase of 25% lease value over the previous rate, then a 10% annual increment is applied. While year wise details

have been given in Table 5.5, the lease fees *vis a vis* the cost per hectare have been increased significantly over the years.

Table 5.5: Lease fee of the study beels

Year	Hamil beel		Rajdhala beel	
	Taka	Tk/ha.	Taka	Tk/ha.
1997-98	29,288	1,803	200,600	3,877
1998-99	32,217	2,013	226,600	4,257
1999-2000	40,217	2,514	242,000	4,566

For example, the lease fee of Hamil beel was Tk. 29,288 in 1997-98 and the same went up to Tk. 40,217 in 1999-2000. Similarly, in Rajdhala beel it was Tk. 200,600 in 1997-98, which went up to Tk. 249,260 in 1999-2000.

In addition to the high cost of lease value as discussed above, delayed hand over of the beels especially in case of Rajdhala has had a serious effect and due to shorter tenure period, the development of the resource was hampered.

5.4.2 Financial management for fisheries activities

In case of Hamil beel it would be seen that the yearly expenses declined from Tk. 152,282 in 1998 to Tk. 128,383 in 2000. Analyzing item wise cost, it would be seen that in Hamil beel cost towards fingerling purchase was Tk. 85,269 in 1998, Tk. 46,501 in 1999 and further came down to Tk. 36,299 in 2000. Similarly, guarding cost also came down from Tk. 16,000 in 1998 to Tk. 7,295 in 2000. However, the lease fee increased each year. From this equation it can be assumed that cost areas that were under the control of the community could be tamed down, which was not possible in case of the lease fee as the same was determined by the leasing authority. The community also became socially responsible gradually as they increased to extend social support to the community people. Expenses on this account rose from 1,500 in 1998 to Tk. 21,050 in 2000. Sales proceeds and net profit also had variables. Income declined from Tk. 550,500 in 1998 to Tk. 433,144 in 2000 in spite of decline in expenses. Nevertheless, the net profit ratio remained almost same each year, *i.e.*, 72%; 68% and 72% respectively in 1998, 1999 and 2000. Tables 5.6 and 5.7 present the total income and expenditure scenario in both the beels.

Table 5.6: Expenditure and Income of Hamil beel

Item	1998	1999	2000
Expenditure (Tk.)			
Lease fee	29,288	32,217	40,217
Fingerling	85,269	46,501	36,299
Net purchase	10,000	4,847	7,696
Boat making	6,000	421	4,020
Guarding	16,000	15,220	7,295
Meeting	1,025	3,662	4,295
Transport	1,200	6,226	7,511
Liming	2,000	0	0
Miscellaneous	1,500	18,498	21,050
Total	152,282	127,592	128,383
Income (Tk.)			
Sale from stocked fish	407,100	233,665	286,974
Sale from non-stocked fish	143,400	169,157	146,170
Total	550,500	402,822	433,144
Profit	398,218	275,230	304,761

In Rajdhala beel the income vs. expenditure scenario was of mixed nature (Table 5.7). Like Hamil beel cost towards fingerlings observed a steady decrease *i.e.*, from Tk. 175,292 in 1998 to Tk. 165,564 in 1999 and Tk. 146,085 in 2000. The guarding cost also came down from Tk. 9,150 in 1998 to Tk. 4,000 in 2000. It is interesting to note that the community had to spend Tk. 25,487 for nursery pond in 1998, which came down to Tk. 10,210 in 1999 and in the following year no cost was incurred as the community established the ponds by purchasing land in 1999 for which Tk. 36,000 was spent. Rajdhala community also had to spend Tk. 24,629 towards meeting court expenses during 1999 and 2000 respectively, which was not incurred for Hamil beel.

Regarding total expenses, it was Tk. 495,270 in 1998, went a little up in 1999 to Tk. 515,078, but declined to Tk. 441,343 in 2000. As far as income is concerned the community had to sustain a loss of Tk. 89,605 in 1998 because there was no stocking in the previous year and therefore only Tk. 58,645 was received from the sale of stocked fish. However, in the following year, a sharp increase of income was recorded. After meeting the deficit of previous year (Tk. 89,605) the net profit amounted to Tk. 393,301. The profit fell down in 2000 *i.e.*, Tk. 197,611.

Table 5.7: Expenditure and Income of Rajdhala Beel

Item	1998	1999	2000
Expenditure (Tk.)			
Lease fee	206,000	226,600	249,260
Fingerling	175,292	165,564	146,085
Nursery pond	25,487	10,210	0
Net	49,779	10,000	14,998
Boat purchase	5,600	2,000	3,000
Guarding	9,150	5,825	4,000
Meeting	0	2,495	1,200
Transport	0	3,277	4,900
Liming	8,320	30,000	0
Katha	10,000	5,278	1,900
Land purchase		36,000	
Court Fees	0	10,629	14,000
Miscellaneous	5,642	7,200	2,000
Total	495,270	515,078	441,343
Income (Tk.)			
Sale from stocked fish	58,654	696,278	398,717
Sale from non-stocked fish	347,001	301,706	240,237
Total	405,665	997,984	638,954
Profit	(89,605)	393,301	197,611

5.4.3 Benefit distribution and future investment provisions

After marketing the products benefits were distributed to each of the members. The modalities of the distribution have been decided well before the actual distribution of profit took place. The net profit have been calculated considering all the expenses incurred in terms of input cost, management cost and other associated cost related to the production. As total transparency has been maintained and all the dealings were done in a systematic manner, there was hardly any suspicion or question on the net profit. At the end of the day's activities all dues have been settled. It was decided earlier that BMCs would retain a percentage from the net profit for future reinvestment. The rate was agreed at 20% of the total profit. Installing this system BMCs have been able to devise an inbuilt system of expanding their financial base, which would supplement their future undertakings.

Table 5.8: Benefit distribution

Beel	1998	1999	2000
	Tk/ind	Tk/ind	Tk/ind
Hamil	2,708	2,023	2,161
Rajdhala	(1,006)	4,229	2,124

Tk.-Taka; Ind.-Individual

From Table 5.8 it may be seen that in Hamil Beel per capita income ranged from Tk. 2,023 in to Tk. 2,708, which was distributed equally. But in Rajdhala beel it showed significant improvement as in 1999 it rose to Tk. 4,229 from deficit of Tk. 1,006 in 1998.

5.4.4 Income generation projects

IGPs were given to both individual members and also collective members to the groups. For individual members the rate of interest was charged at 12% (same percentage is applied for Caritas Bangladesh credit program). For group projects however, it was free of interest. Normally group loans were given for purchasing boats, nets, setting up nurseries etc. For individual IGPs it was both with fisheries and non-fisheries types of activities.

It was noted that with the progress of time, ceiling of individual IGPs rose from Tk. 1,500/member in 1996 to Tk. 6,000/member in 2000. Credit recovery rates have been satisfactory. Data was aggregated for three study years and it was found that the recovery rate was over 91%. However, there have been difficulties in realizing the loans especially after the flood of 1998. But remarkably all the borrowers have paid the loaned amount with the service charges during 1999. To be able to respond to the need of the beneficiaries, a grace period was given for the group members to compensate for the loss. Table 5c (Annex-A) would show that a total of Tk. 863,461 was disbursed for IGPs in both Hamil and Rajdhala beel. Hamil beel groups borrowed Tk. 408,961 and Tk. 454,500 was given to Rajdhala beel community. The table further shows that maximum amount of borrowing was on account of kitchen gardening and poultry raising. This alone accounted about 27% of the total disbursement.

5.5 Fisheries management

With the gradual strengthening of BMC through the process of clear-cut understanding of its mandate and function, it (BMC) had taken adequate measures to ensure the access to the resources. All the activities relating to the access were being done by BMC under a very well

devised structure. During the planning meetings BMC takes decisions on certain strategic matters and also chalks out plans to address such strategic issues. Decisions were taken on the requirement of capital for stocking and from which source such capital would be arranged. With regard to the assistance of Caritas, the BMC also set its target in view of their requirement. Having agreed upon all these issues, communication is made with respective organizations with distribution of responsibilities to BMC members to accomplish the designated tasks. In the next meeting the decisions that have been made in the previous proceedings are followed up. In respect of the above, the operational management plan has also been devised for both stocked and non-stocked fishing. The BMCs observed its due process deciding on the number, size, and species of fingerlings stocked. Since stocking time is an important factor, due consideration have also been given to this aspect. When this was agreed upon, the source from where the fingerlings would be purchased was also decided taking into consideration of the quality of the fingerlings.

The researcher, after going through the proceedings of the functioning of the BMCs especially in the field of fisheries management found that from time to time BMCs sought guidance and assistance from different organizations/institutes in determining the standard and quality of the fingerlings. Ample support was also received from Fisheries Research Institute (FRI), Caritas as well as from respective DFOs. This manifests the openness of the BMCs in accepting the ideas of the technical experts, as their (BMCs) technical capability was not adequate to exclusively decide on such technical matters.

The above was applicable for the management of both stocked and non-stocked fishes in the beels. The researcher took note of the fact that the production level of stocked species was satisfactory during the study period and the production from non-stocked production was no meager. Great importance was also given on the production from non-stocked species too. The fisher groups maintained the notion that combining both stocked and non-stocked fish and calculated their yield. Separated records have been maintained on non-stocked species and comparison was made after each of harvesting. It was noted that fishers sold the stocked species only and kept the production from non-stocked species for their own consumption. This way they have maintained the requirement of nutrition intake in their daily diet. This was possible because of their ability to sell the stocked products in the market for profit.

5.5.1 Stocking in the beel

Hamil beel

Hamil beel has been stocked in each year with fingerlings of Indian major carps since 1972.

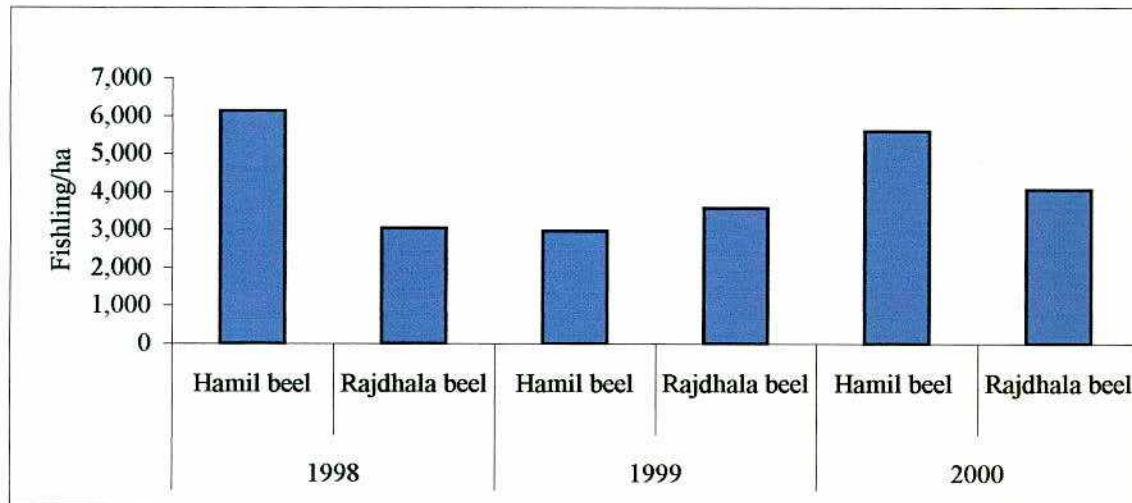


Figure 5.1: Stocking status in the studied beels

In 1997, stocking started in May and continued up to June 1998 and a total of 98,110 (Figure 5 f, Annex-A) fingerlings were stocked in the beel. In addition more than 100 kg of common and mirror carps were released back into the same beel, which bred naturally and consequently contributed in the catch of 1998. Stocking rate was highest, 6,132 ind/ha in 1998 and the lowest, 2,963 ind/ha in 1999 (Figure 5.1). In 2000, the beel was stocked with at the rate of 5,587 ind/ha water body and started from the month of March and continued up to September.

The beel was stocked with 6 kind of fingerlings both endemic and exotic, *viz.* silver carp, grass carp, common carp, catla, rohu, and mrigal in all three years. BMC stocked the beel with fingerlings considering food niche of the waterbody, as natural food was only the source of fish nutrition and survival. Catla was dominant species contributed to the production in 1998. So, fishers took attempt to stock catla more in all these study years, where its stocking density was 1,610 ind/ha in 1998, 878 ind/ha in 1999 and 1,738 ind/ha in 2000 respectively.

Rajdhala beel

In Rajdhala beel, stocking density was 3,036 ind/ha and catla ranked the top among the 6 species, *i.e.*, 1103 ind/ha. Considering bottom vegetation, the community was also interested to stock with more grass carp. As the beel came under the community control in late August,

they started stocking in September (Plate g, Annex-C). In 1999, the stocking rate was 3,562 ind /ha. and catla was again the dominant species (Figure 5.1). On the other hand, the stock of silver carp for 1998 did not put much contribution in 1999 harvest and afterwards the BMC was found to reduce its stocking densities.

5.5.2 Guarding

In view of the ownership over the resources, it has been continuously discussed that the community must take initiative to protect the fish from poachers. The fishers were able to understand that they should take the responsibility for safeguarding their products. It may be pointed out that guarding system was in place before the study period. CBFM Project initiated the concept of community guarding and there have some modifications over the period of time. The researcher was actively involved during introduction, designing of the guarding system. The process was recorded and data was preserved.

Taking 9-10 members from six organized fisher groups in Hamil beel the BMC formed fourteen guarding groups. BMC also developed the guarding system. Twenty four hours

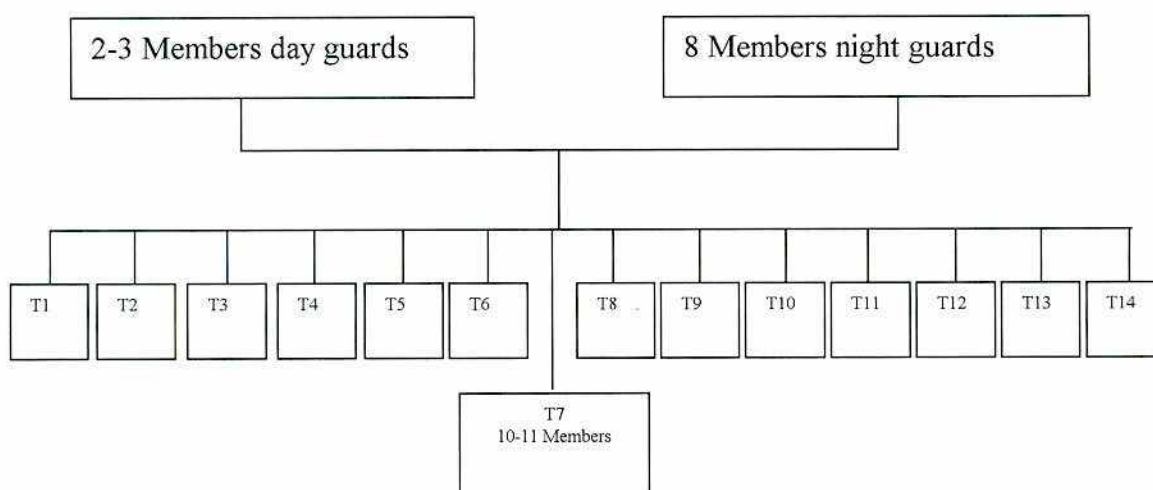


Figure 5.2: Guarding arrangement in the beel

vigilance system was established. For 14 days 2 members of the guarding groups maintained vigilance during the daytime and the rest did the guarding during the night. Figure 5.2 depicts the guarding system in the beel.

The beel was protected against premature fishing activity from May until September. From the months of October to February the system changed and 9 harvesting team were formed.

Each group, consisted of 14-15 members in which at least one member was from the organized 6 groups. The responsibility rotated according to the activities. Out of those 9 groups, 2 were engaged for day and night fishing, while 2/3 members of group 1 did the guarding, and the other 12 members of the same group were engaged for harvesting during daytime. Members of group 2 followed the same procedure during the night fishing.

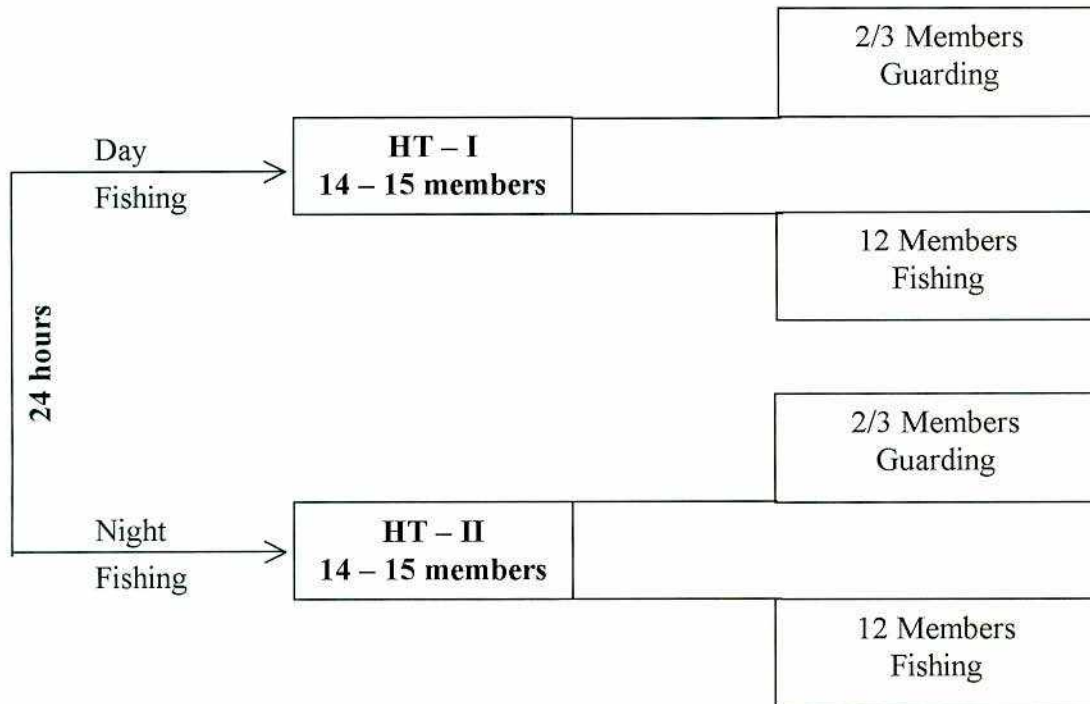


Figure 5.3: Guarding arrangement during harvesting period

During the harvesting period the guarding pattern changed. These new teams were larger (15 members) and at least one member from each of the six fishing groups belonged to each harvesting team. Two of the three members of team I, were responsible for guarding while the other 12 members of the same team were engaged in fishing during the day. The members of team II followed the same pattern during the night (Fig. 5.3).

5.5.3 Fish harvesting

Hamil beel

Fish production was found to fluctuate in Hamil beel during the study period. In respect of fish catch both Hamil and Rajdhala beel, it showed an inverse correlation between stocked and non-stocked fishes. In 1998, harvesting from Hamil beel started in September 1997 and

continued up to February regularly. After 7 months a second harvest occurred from October 1998 to February 1999. In 1998, the stocking density was higher, which contributed to 1999 production, i.e., 782.8 kg/ha. During 1999 and 2000 harvest, catla ranked the top among all species of the respective years. At a glance the total fish yield of Hamil beel was recorded 793.6 kg/ha in 1998, 782.8 kg/ha in 1999 and 685.4 kg/ha in 2000. A significant portion was measured as non-stocked fish, i.e., 240.5 kg/ha, 331.9 kg/ha and 196.9 kg/ha respectively (Fig. 5.4).

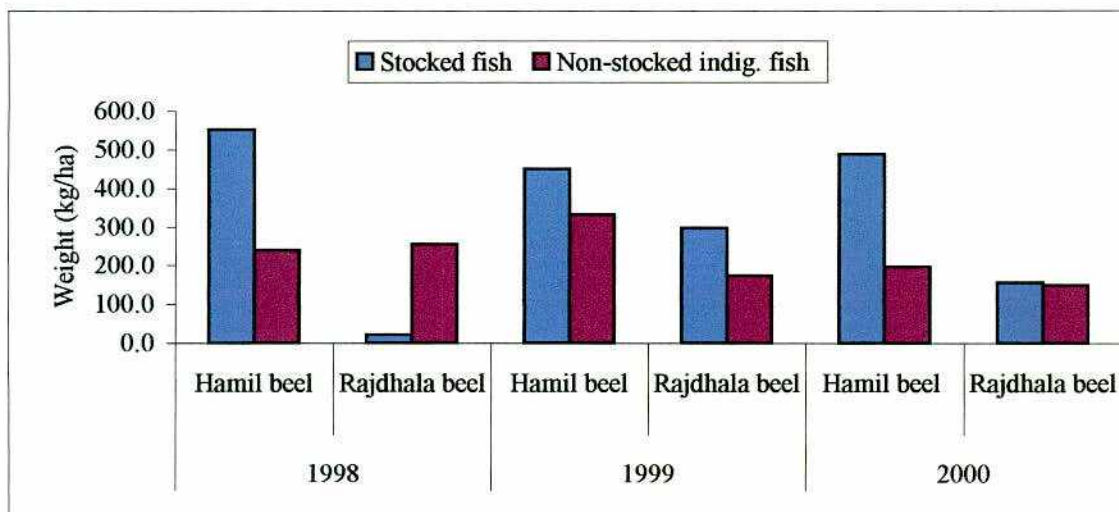


Figure 5.4. Status of stocked and non-stocked fish yield of the studied beels

Yield of silver carp compared to catla was found less. It was observed clear food competition between catla and silver carp and in between Indian river shade and silver carp. Mrigal was found the dominant stock accompanied with common carps among the bottom dwelling fishes. Catching performance of these fishes was found always promising, which was very much related to abundance of benthic animals in the beel.

Rajdhala beel

In 1998, fish harvest from Rajdhala beel was 275 kg/ha of which 20.6 kg/ha from stocked fish (Plate b, Annex-C) and the rest from non-stocked indigenous fish. Consequently, it was recorded 471.9 kg/ha in 1999 and 306 kg/ha in 2000.

In 1998, stocked fish catching was dominated by grass carp, *i.e.*, 15.7 kg/ha out of 20.6 kg/ha.



Plate 5: Harvesting in Rajdhala beel

Stocked vs. non-stocked indigenous fish

A major portion of catch was contributed by non-stocked indigenous fish every year. They are named locally chapila, punti, chanda, mola, chela, boal, guji and others. Total fish yield of Hamil beel was 793.6 kg/ha in 1998, 782.8 kg/ha in 1999 and 685.4 kg/ha in 2000. Similarly, Rajdhala beel produced 275 kg/ha of fish, where stocked fish was 20.6 kg/ha and non-stocked fish was 254 kg/ha in 1998 followed by 471.9 kg/ha where stocked fish was 297.3 kg/ha and non-stocked was 174.6 kg/ha in 1999 and 305.9 kg/ha in 2000 where stocked fish was 156.5 kg/ha and non-stocked fish was 149.4 kg/ha respectively. The catch in 1998 showed that guji (*Aorichthys* sp.), the most dominant species (32% of the total catch by weight) in Hamil beel, while chapila (*Gudusia chapra*) was the dominant species (85%) in Rajdhala beel in the same year. In 1999, chapila was dominant among the non-stocked fish in both Hamil and Rajdhala beels, *i.e.*, 35% and 88% (Fig 5a, 5b, Annex-B). In 2000, *Gudusia chapra* also increased in Hamil beel (46%), but Rajdhala was dominated by chanda (*Leiognathus* sp.) *i.e.*, 55% of the total non-stocked fish.

5.6 Physico-chemical properties

The majority of physico-chemical parameters of the studied beels have been presented in Annex-B. During the study period, water temperature, transparency, water depth, pH, dissolved oxygen, free carbon dioxide, alkalinity, hardness, ammonia and nitrite were measured and analyzed.

5.6.1 Water temperature

The fluctuation of water temperature in both the beels was found marginal during the study period. The range of water temperature of Hamil Beel and Rajdhala beel varied from 21.7°C to 31.7°C and 22.3°C to 30.0 °C respectively. The temperature was highest in summer months and lowest in winter months in both the beels. It was recorded a steady increment of water temperature till mid October and dropped again from mid October to January. The scenario was almost same in 1998, 1999 and 2000. The average value of standard deviation of Hamil and Rajdhala beel was 28.6 ± 2.54 and 27.7 ± 2.72 respectively (Fig. 5c, Annex-B).

5.6.2 Transparency

The water transparency ranged from 20.7 cm to 80.5 cm at Hamil beel and 39.0 cm to 83.7 cm at Rajdhala beel. It was highest during July (1998) and the lowest during May (1999) in Hamil beel. On the other hand the transparency was recorded lowest in July (1998) and highest in November (1999) in Rajdhala beel (Fig. 5.5). The average transparency was higher in Rajdhala beel. The average value of standard deviation of Hamil and Rajdhala beel was 45.5 ± 14.54 and 64.7 ± 14.29 respectively.

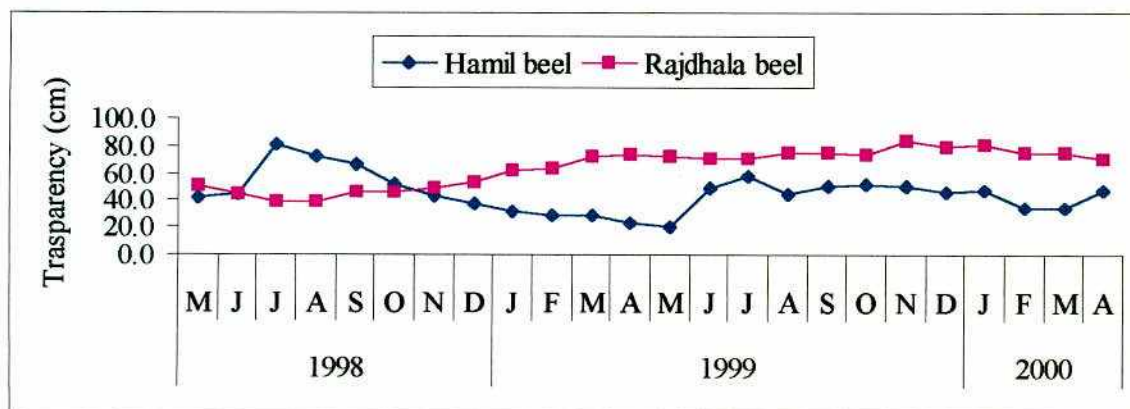


Figure 5.5: Monthly water transparency in the studied beels

5.6.3 Water depth

The water depth ranged from 1.2 m to 2.9 m at Hamil beel and 1.6 to 6.7 m at Rajdhala beel. During the flood of September 1998 it was highest in both of the beels. The water depth was lowest during the dry season. The average water depth was higher in Rajdhala beel. The average value of standard deviation of Hamil and Rajdhala beel was 1.7 ± 0.49 and 4.5 ± 1.13 respectively.

5.6.4 pH

The water pH in Hamil beel reported from 6.9 to 9.5 while in Rajdhala beel it was 7.0 to 8.2. The pH readings of the two beels were more or less similar. The water of Hamil

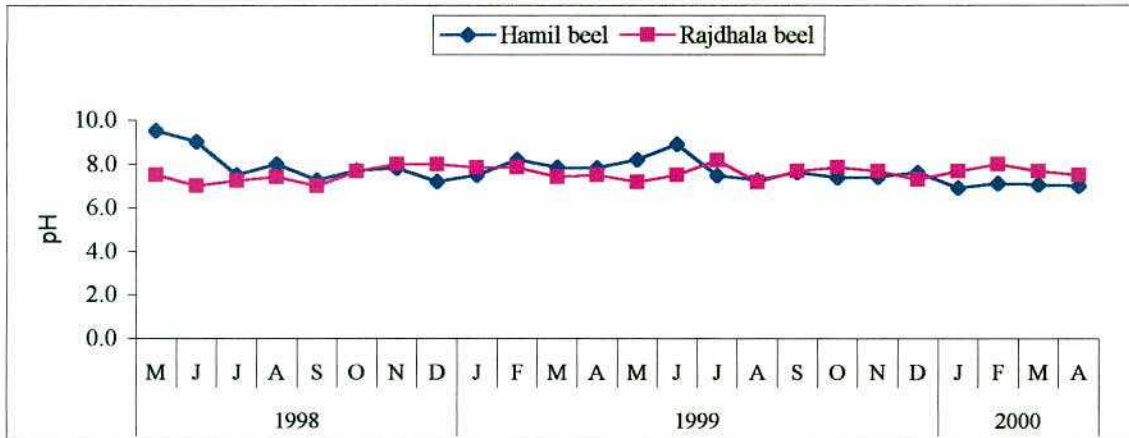


Figure 5.6: Monthly water pH in the studied beels

beel was basic except slightly acidic (6.9) in January (2000) and neutral in April of the same year. In Rajdhala beel it was alkaline and neutral in July of 1998 as well as in September of the same year. The average value of standard deviation of Hamil beel and Rajdhala beel was 7.7 ± 0.65 and 7.6 ± 0.32 respectively.

5.6.5 Dissolved oxygen

The dissolved oxygen content of Hamil beel was within the range of 5.2 to 6.5 mg/l and 5.3 to 10.3 mg/l at Rajdhala beel. It was observed that the average oxygen content was higher in Rajdhala beel. Dissolved oxygen was above 6.0 mg/l between May to October 1998. But the

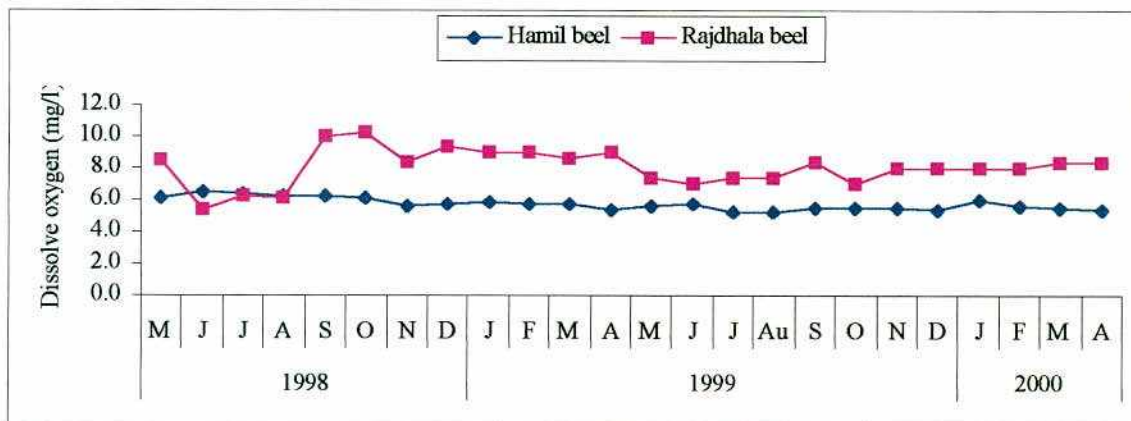


Figure 5.7: Monthly dissolve oxygen in the studied beels

rest of months it was below 6.0 mg/l except in January 2000 (6.0 mg/l) in Hamil beel. In case of Rajdhala beel it was 10.0 mg/l and 10.3 mg/l in September and October of 1998 respectively and below 7.0 mg/l in June and August of 1998 and it was 7.0 mg/l in June 1999 and October of 1999 and the rest were above 7.0 mg/l. The average value of standard deviation of Hamil and Rajdhala beel was 5.7 ± 0.36 and 8.0 ± 1.19 respectively (Fig. 5.7).

5.6.6 Free carbon dioxide

The values of free carbon dioxide of Hamil and Rajdhala beel were found to vary from 3.7 mg/l to 9.2 mg/l and 4.2 mg/l to 6.3 mg/l respectively. The free carbon dioxide content in both of the beels was low. The free carbon dioxide content of Hamil beel was above 6.0 mg/l in December (1998), February to March (1999) as well as February to April (2000), but in the rest of months it was below 6.0 mg/l. In Rajdhala beel the value was 6.0 mg/l in May (1999) and in the rest of months was below 6.0 mg/l. The average value of standard deviation of Hamil and Rajdhala beel was 5.3 ± 1.69 and 5.2 ± 0.59 respectively (Fig. 5d, Annex-B).

5.6.7 Alkalinity

The alkalinity of Hamil beel and Rajdhala beel ranged from 17.1 to 89.9 mg/l and 22.8 to 108.3 mg/l respectively. Of the two beels, the average alkalinity content was highest in Rajdhala beel. In Hamil beel, the alkalinity content was lowest in May (1998) and February to April of 2000, but it was highest in December in 1998. It was lowest in March of 2000 at Rajdhala beel, while it was above 100 mg/l in September, December of 1998, January, September and October of 1999 as well as February in 2000. The average value of standard deviation of Hamil and Rajdhala beel was 48.4 ± 22.32 and 82.1 ± 23.47 respectively (Fig. 5e, Annex-B).

5.6.8 Hardness

The hardness of Hamil beel ranged from 17.1 to 113.0 mg/l whereas it was 22.8 to 114.0 mg/l at Rajdhala beel. The average hardness content of Rajdhala beel was higher. The lowest value was in June (1998), February–April (2000), but it was above 100 mg/l in August–September (1998) in Hamil beel. In Rajdhala beel the lowest value was in May (1998) and the above 100 mg/l in September, October, and December of 1998, January, March, April of 1999 as well as January (2000). The average value of standard deviation of Hamil and Rajdhala beel was 52.5 ± 29.03 and 82.9 ± 24.53 respectively (Fig. 5f, Annex-B).

5.6.9 Ammonia

The ammonia content of both the beels was insignificant quantities. It was ranged from 0.0 to 0.5 mg/l at Hamil beel and 0.0 to 0.25 mg/l at Rajdhala beel. The average value of standard deviation of Hamil and Rajdhala beel was 0.1 ± 0.17 and 0.2 ± 0.1 respectively.

5.6.10 Nitrite

Nitrite content of both the beels was also insignificant. It ranged 0.0 to 0.1 mg /l and 0.0 to 0.2 mg/l at Hamil and Rajdhala beel respectively. The average value of standard deviation of Hamil and Rajdhala beel was 0.0 ± 0.02 and 0.1 ± 0.04 respectively.

5.7 Biological parameters

Biological parameters included plankton and benthic fauna.

5.7.1 Plankton

Monthly fluctuations of plankton have been observed. It appeared that the range of plankton groups had fluctuated numerically during the course of this study in both the beels. The plankton density at Hamil beel ranged from 821 to 6,646 ind/l, whereas it was 710 to 2,676 ind/l at Rajdhala beel during the study. The highest density of plankton observed in Hamil beel in April 2000 and it was lowest in October 1998, whereas in Rajdhala beel, it was highest in July 1998 and lowest in February 2000. The density was below (2,000 ind/l) in September 1998 - January 1999 and August 1999 - October 1999 in Hamil beel, while in Rajdhala beel it was above 2,000 ind/l in May-August and December 1998, March 1999 and April 2000. The average density of plankton was higher in Hamil beel with compared to Rajdhala beel. The zooplankton was higher in Hamil beel but it was lower in Rajdhala beel, on the other hand, phytoplankton was higher in Rajdhala beel and lower in Hamil beel.

Phytoplankton

Phytoplankton density in Hamil beel ranged from 307 to 5,137 ind/l, while in Rajdhala beel it was 321 to 1,389 ind/l. In Hamil beel the phytoplankton density was higher (<1000 ind/l) in every March and June except May and June of 1999. It was highest in May 1998, while it was lowest in January 1999. In Rajdhala beel the highest was in April 2000 and the lowest in March 2000. Phytoplankton density was recorded above 1,000 ind/l in May-October 1998,

January- April 1999 and April 2000 in Rajdhala beel. The average density of phytoplankton was higher in Hamil beel than to Rajdhala.

The population density of phytoplankton was recorded higher in 1998 in Hamil beel, subsequently it was low in 1999, but gradually increased in 2000. On the contrary it was almost the same trend in population density in Rajdhala beel (Fig. 5.8).

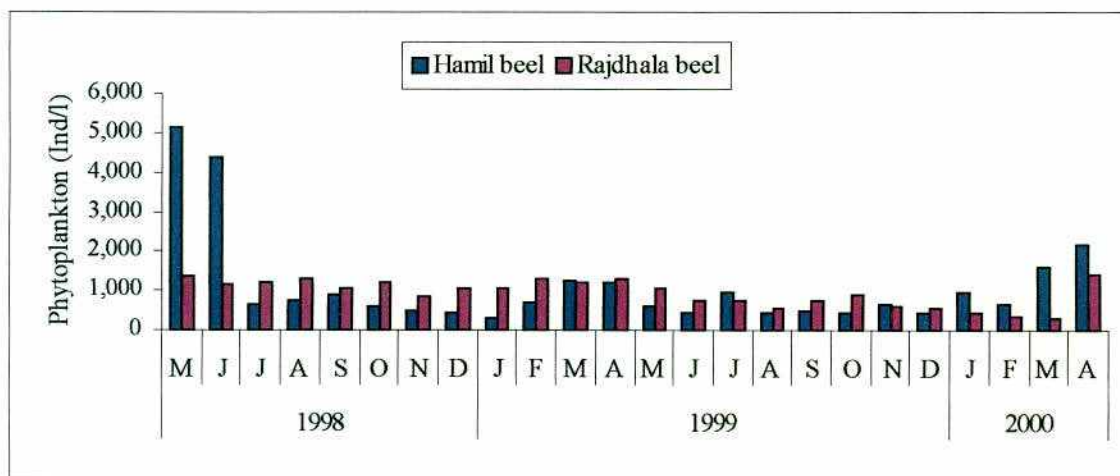


Figure 5.8: Monthly abundance of phytoplankton in the studied beels

Diverse categories of phytoplankton were recorded in both the beels. These were Chlorophyceae, Cyanophyceae, Euglenophyceae and Bascillariophyceae. In Hamil beel Chlorophyceae was the dominant group, whereas in Rajdhala beel the group Cyanophyceae was the dominant. The second, third and fourth dominant group was Bascillariophyceae, Cyanophyceae and Euglenophyceae respectively in Hamil beel. On the other hand, the second, third and fourth dominant group in Rajdhala beel were Chlorophyceae, Bascillariophyceae and Euglenophyceae respectively.

Zooplankton

The zooplankton density in Hamil beel ranged from 378 to 4,707 ind/l, whereas it was 289 to 1,476 ind/l in Rajdhala beel. The density was below 1,000 ind/l in September of 1998, January of 1999, August - October of 1999. The highest and lowest densities were in April of 2000 and October of 1999 in Hamil beel, whereas they were in July-September of 1998 at Rajdhala beel. The zooplankton was above 1,000 ind/l in May, August, November and December 1998 and March of 1999. There was a sharp fall from April of 1999 and April of 2000. The average density of zooplankton in Hamil beel was higher than that of Rajdhala (Fig. 5.9).

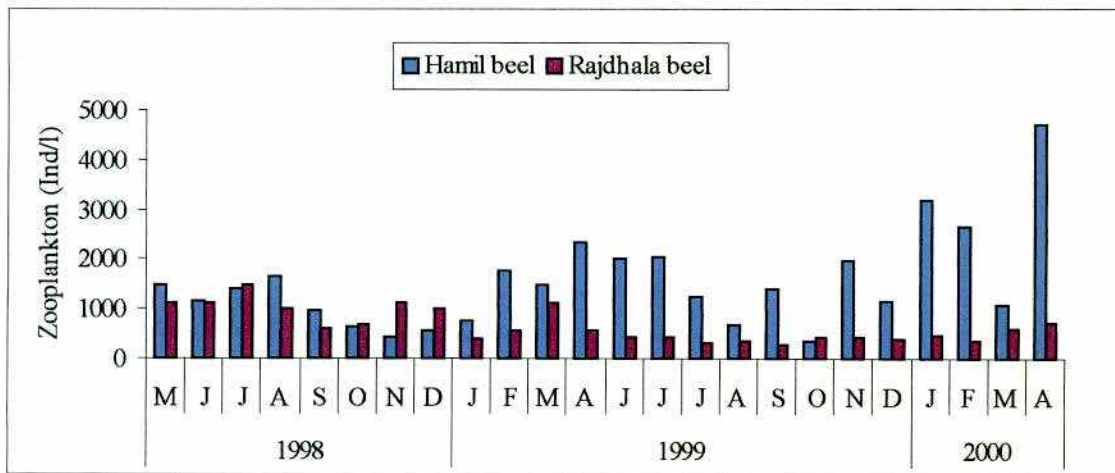


Figure 5.9: Monthly abundance of zooplankton in the studied beels

A number of zooplankton faunas were identified and classified during study period. They were Rotifera, Copepoda, Cladocera, Ostracoda, Protozoa and Nauplii. In Hamil beel and Rajdhala beel the most dominant group was Rotifera. In both the beels the second and fifth dominant group was the Cladocera and Ostracoda respectively. In Hamil beel the third and the fourth dominant groups were Protozoa and Copepoda respectively. On the other hand the third and the fourth groups were Copepoda, and Protozoa in Rajdhala beel respectively.

5.8 Benthic fauna

The benthic fauna ranged from 300 to 2,706 ind/m² and 355 to 919 ind/ m² in Hamil beel and Rajdhala beel respectively. In both the beels the most dominant group was Mollusca followed

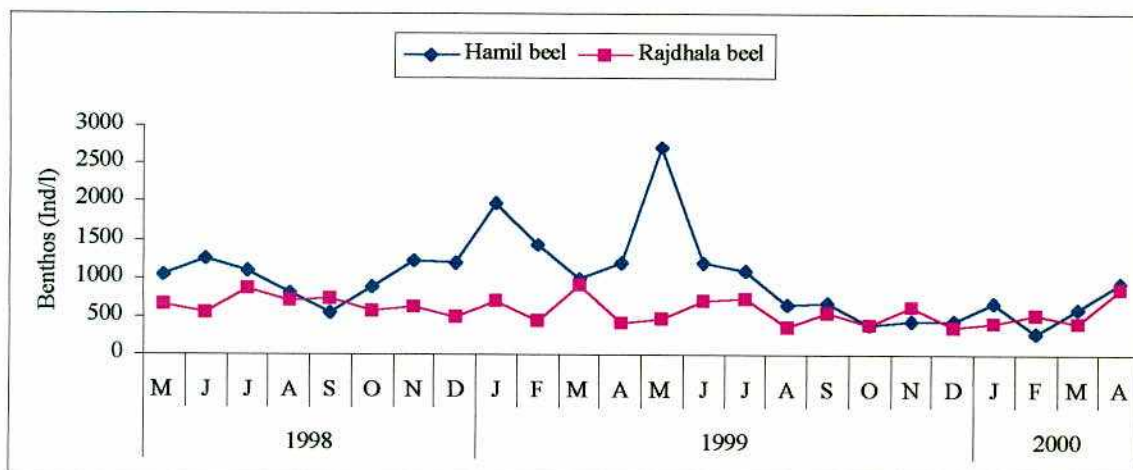


Figure 5.10: Monthly abundance of benthic fauna in the studied beels

by Oligochaeta and Chironomidae respectively. The highest and lowest density was recorded in May 1998 and February 2000 in Hamil beel, while it was in March-December 1999 in Rajdhala beel respectively (Fig. 5.10). In Hamil beel it was above 1,000 ind/m² in May and July 1998 and November 1998-July 1999 except March 1999. In Rajdhala beel it was always below 1,000 ind/m². Benthic fauna was classified into Mollusca, Oligochaeta, Chironomidae and others. Everything was done systematically (Plate h, Annex-C).

5.8.1 Mollusca

Mollusca ranged from 92 to ind/m² in Hamil beel whereas it was 29 to 593 ind/m² in Rajdhala beel. The highest and lowest densities were in Hamil beel in May 1999 and February 2000, while they were in July 1998 and March 2000 in Rajdhala beel (Fig. 5g, Annex-B).

5.8.2 Oligochaeta

Oligochaeta ranged 44 to 903 ind/m² in Hamil beel whereas at Rajdhala beel it was 59 to 371 ind/m². The highest and lowest density were recorded in May and December 1999 in Hamil beel respectively, while they were in August 1998 and April 1999 in Rajdhala beel (Fig. 5h, Annex-B).

5.8.3 Chironomidae

Chironomids ranged from 59 to 1,011 ind/m² in Hamil beel, whereas in Rajdhala beel it was 15 to 326 ind/m². The highest and the lowest densities were observed in March and October 1999 respectively in both the beels (Fig. 5i, Annex-B).

5.9 Inter relationship between biotic and abiotic parameters

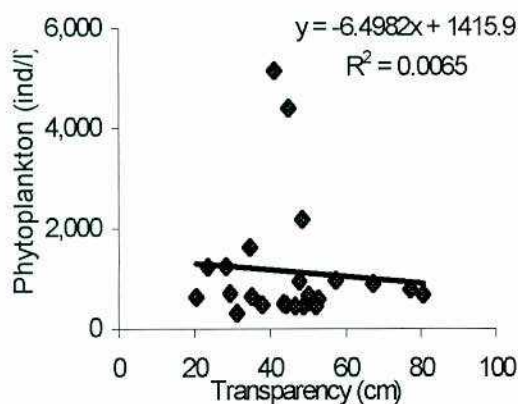


Fig. 5.11 Effect of transparency on phytoplankton in Hamil beel

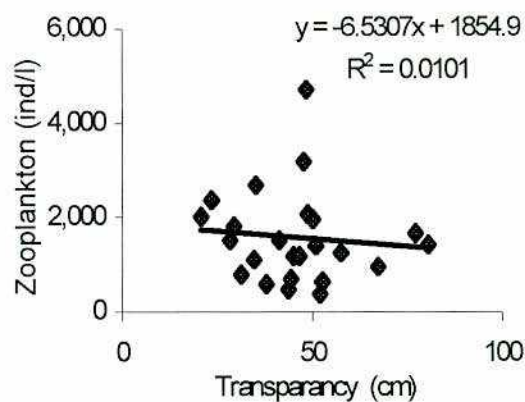


Fig. 5.12 Effect of transparency on zooplankton in Hamil beel

In Hamil beel transparency and phytoplankton were found negatively correlated ($P < 0.01$). The phytoplankton populations were found highly influenced by the transparency. It was also observed that the abundance was more concentrated within 40-50 cm. of transparency level (Figure 5.11). The zooplankton population followed the same trend as of phytoplankton in Hamil beel. The highest concentration of zooplankton was observed between 40 and 50 cm. (Figure 5.12). The relationship was found statistically significant ($P < 0.01$).

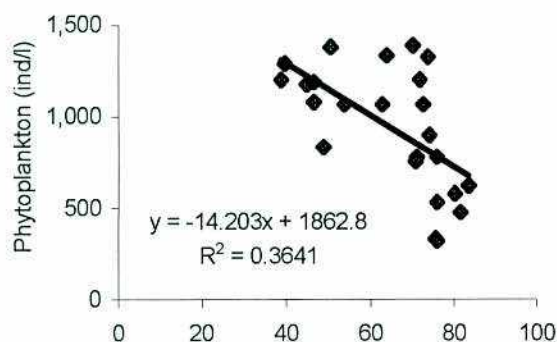


Fig. 5.13 Effect of transparency on phytoplankton in Rajdhala beel

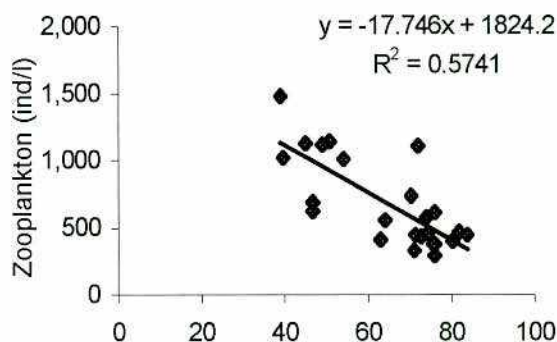


Fig. 5.14 Effect of transparency on zooplankton in Rajdhala beel

The relationship between transparency and phytoplankton was found negatively correlated ($P < 0.01$) in Rajdhala beel (Figure 5.13). The zooplankton population was also found negatively correlated ($P < 0.01$) in the same beel (Fig. 5.14). The concentration of zooplankton was found between 70 and 90 cm. level of transparency.

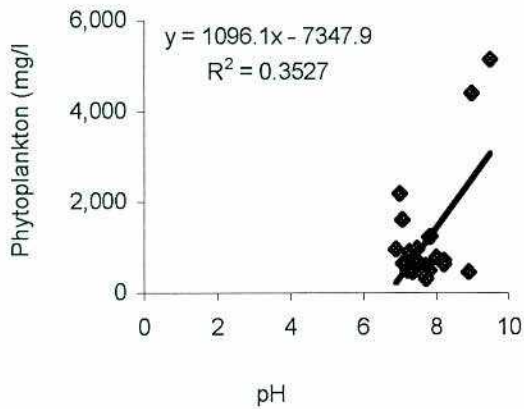


Figure 5.15 Effect of pH on phytoplankton in Hamil beel

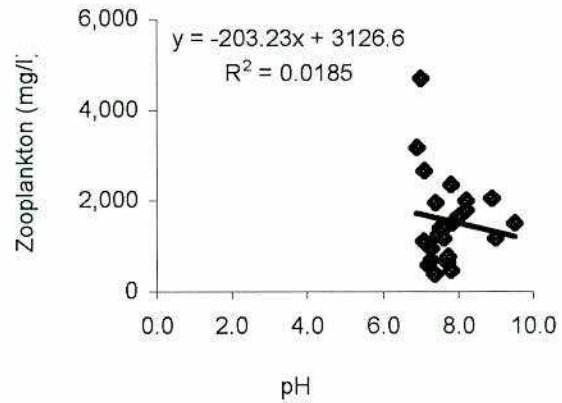


Figure 5.16 Effect of pH on zooplankton in Hamil beel

A significant positive correlation was observed between phytoplankton and pH in Hamil beel (Fig. 5.15) while the relationship between zooplankton and the pH was found negatively correlated in the same beel (Fig. 5.16). Highest concentration of phytoplankton was found between pH 6 and 8.

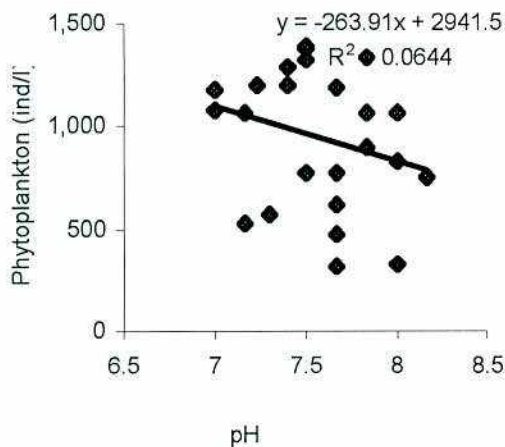


Figure 5.17: Effect of pH on phytoplankton in Rajdhala beel

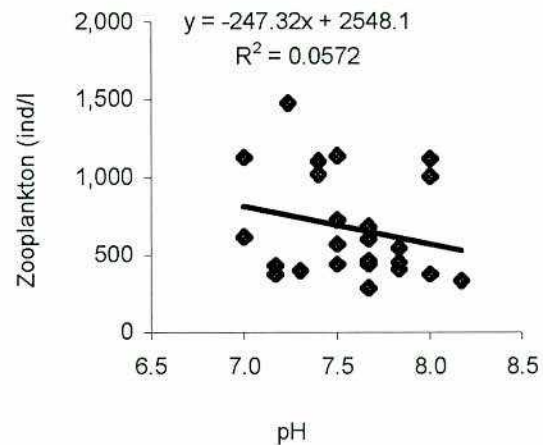


Figure 5.18: Effect of pH on zooplankton in Rajdhala beel

In Rajdhala beel the relationship between phytoplankton and pH was found negatively correlated (Fig. 5.17). Similar trend was also found in case of zooplankton and pH in the same beel (Fig. 5.18).

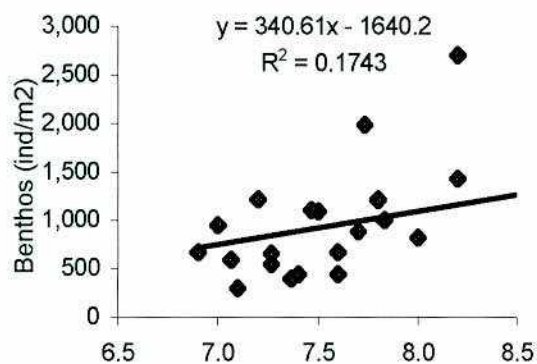


Figure 5.19: Effect of pH on benthos population in Hamil beel

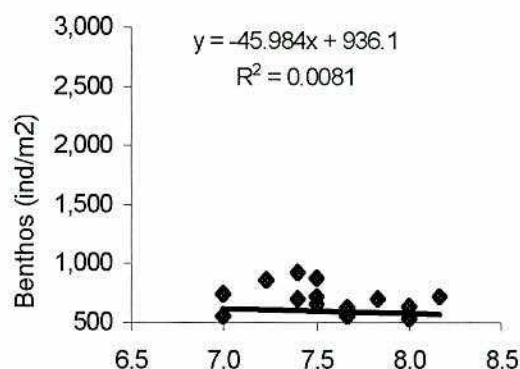


Figure 5.20: Effect of pH on benthos population in Rajdhala beel

In Hamil beel benthos communities varied with water pH between 6 and 10. Benthos and pH exhibited a pronounced linear relationship. The highest concentration of benthos was observed between pH 6.5 and 8 (Fig. 5.19). In Rajdhal beel no such correlationship was observed between benthos and pH. However it appeared from figure 5.20 that benthic populations fluctuated between pH 7 and 8.

CHAPTER 6

DISCUSSION

6.1 Human capital

6.1.1 Organizing the community

Community Based Fisheries Management (CBFM) project has been formulated from the experiences of different initiatives in management of fisheries resources. From previous experiences it was identified that *organizing the community* is an essential part, especially for an initiative like CBFM Project. Community based management strives for a more active people's participation in the planning and implementation of fisheries management (Pomeroy, 1994). Since organizing the community has been viewed as an essential element, then the participation of the community in the process is also very crucial. Oakley and Marsden (1984), mentioned that for participation to be meaningful, it must involve some direct access to decision-making and the active involvement of the beneficiaries in determining problems and practices. It was therefore necessary to ensure the full and active participation of the beneficiaries in the process of community organizing, as they would be the key actors in fulfilling the objective of the project. The Participatory Development Learning Group (PDLG), composed of World Bank staff with interest, experience and involvement in participatory approaches closely follow Oakley and Marsden by defining participatory development as a process through which stakeholder influence and share control over the development initiatives, decisions and resources which affect them (World Bank, 1994).

Participation is a concept with multiple meanings (Rozario, 1998). Various aspects of the concept have been debated at length, for example, its historical origin, its theoretical connotation and practical applicability. Stakeholder analysis conducted through PRA and later with FGD, have been attempted to clarify the roles and responsibilities at different tiers of the functionaries. Stakeholder analysis identified who has a stake, the nature of their interest and clarifies the relationship between the groups (Hoggarth *et. al.*, 1999). Although CBFM primarily concerns fisheries, but the necessity of PRA exercise was to achieve multiple purpose. According to FAO (2000), participatory approaches may not be applied specifically to aquaculture but are used to undertake an overall assessment, led by local people, to identify key problems and potential that might include aquaculture along with a range of other developments.

Access of the communities in the study beels has had different dimensions in the nascent stage of the project. Hamil beel community had their access in the beel while the Rajdhala beel was under lease to an influential outsider. It was therefore necessary to adopt two different strategies for mobilizing and organizing the two communities. Cohen and Uphoff (1980) argued that in order to distinguish between different forms of participation, it is necessary to look both at the dimensions of participation in the context in which the participation is situated. In Hamil beel, where the community already had their access to the resource, it was thought imperative to feed the community with the concept and adoption of resource management. But in Rajdhala beel the work started with the process of gaining the access of the community over the resource, *i.e.*, the beel. It was therefore, conducive for the Hamil beel community to take forward their initiative through normal organizing process. It was, on the other hand, quite a daunting task for the Rajdhala beel community, as they had to start from scratch and at the same time had to gradually overcome the outsider lessee.

The social settings, in terms of religion, custom and other social norms have had an influence over the process. For example, Hamil beel community is predominantly Muslim. They also had control over the resource. And due to this control, the leaders had connections with the administration and also enjoyed good rapport with officials of DoF. All these favouring factors helped the community to further consolidate their effort and adapt to the new management measures. In Rajdhal beel however, it was altogether a different scenario. Majority of the community was Hindu by faith and fishermen by profession. According to the high caste hindus, fishing is the work of untouchable people (Alam, 2001). Also observed by Pokrant *et al.* (1997), that a majority, possibly as high as 95% of professional fishers were low caste *asat* (not good) Sudra or “untouchable” Hindus. Panna (1985) pointed out that those who fish are called *Jele*. They are also known as *dhabor*, *kaiborto*. According to the *rigven* (in Sanskrit, *veda*) there were 18 lower caste occupational groups among the hindus in the 11th century and *das* was one of them (Alam *et al.*, 2001). It may be mentioned that all the fishermen of Rajdhala beel are *Das*. This situation automatically put them in a subordinate position within the society. Since the resource was not within their control and because of their subservient attitude, it was an uphill task for them to gain access. The leaseholder and his accomplices continued to threat Caritas personnel in the field and also the respective personnel involved in the project and warned of dire consequences, should they attempt to penetrate in the area. This was perhaps due to the fact that once the community people are organized under a platform then it would be very difficult to manipulate them or even to deprive them from the resource. So, by all means this group wanted to destabilize the situation. Under this condition, the plan to organize and mobilize the community was made in a very meticulous and calculative way keeping in mind the alien features. In spite of all these odds there was also a

situation, which has helped in the mobilization work. Caritas had its presence in the Purbadhala Thana where it had been implementing its DEEDS, which was a part of Caritas's Poverty Alleviation Program. Because of this, Caritas staff has had a good exposure in the locality and good connections with the local administration. This was a positive factor that paved the way for bringing the people under one platform from where the aims and objectives of the project were disseminated. The development at Hamil beel was also brought as an instance. Gradually, the effort started to get momentum and the initial thrust to get the people familiarized with the objective of the project was achieved successfully. Without elaborating it can be concluded that the mere presence of Caritas and its esteem as a social development organization has had great influence over the proceedings at Rajdhala beel.

As mentioned in the process and result chapter, there has been a series of activities for community organizing. This initiative has been found very useful since it was clearly evident that the purpose and objective of the project would help the local community in a number of ways. The community meeting in particular was an eye-opener as one particular section of the community had a different view of CBFM and was also suspicious about the initiative. This was difficult to overcome and made the beneficiary selection process challenging. To avert the difficulties, it was necessary to hold consultations at different tiers of the local administration and also with the Deputy Commissioners and other stakeholders. It was thought imperative that moving alone, without availing the support of the administration, it would be a difficult proposition. This initiative was very helpful and in realizing the objectives of CBFM, the support of the administration was found to be a very effective instrument.

6.1.2 Group formation and activities

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From tables 5.1 and 5.2 it would be seen that most of the groups were formed in 1996. It may be mentioned that the groups were formed long before the study period of the researcher. It is interesting to note that within the period of 4 years of the formation of the groups, the number of members that has left the groups is quite insignificant, which is uncommon in the context of our development paradigm. While dismantling of groups/members is considered a natural phenomenon, it was not the case in the studied beels. There were 180 members in Hamil Beel in 1996 and during March 2000 it was 176. In Rajdhala beel one more member was added. This shows that there was a common ground for the group members to stick together and continue with the process of their livelihood development. During the process of discussion of the study period the researcher attempted to explore the basic reasons of this togetherness. A number of reasons were identified. First of all, the resource and the benefit from it were the principal reason for keeping them together. Second most important element as per the

understanding of the researcher, was perhaps that most of the members are from similar social and occupational background and their social stratification, beliefs, norms, rituals put them in a common binding and with the increasing benefits they have been deriving out of the resource necessitated them to remain together. Another aspect of their strong bond is due to the homogeneous nature of the groups. Sen and Nielsen (1996), while making a comparative analysis of case studies on fisheries co-management. They also observed that if the resource user groups are homogenous functionally, territorially or socio-economically, it contributes to group cohesion. They further observed that where there was socio-cultural heterogeneity in multi-user group situations, co-management was more difficult with government taking bigger role in decision-making. The reality of a group emerges out of people's common perceptions of themselves as members of the same social unit and in various relations to one another within that unit (Asch, 1952; Sharif, 1966). Lewin (1948) believed that groups come into existence in a psychological sense not because their members necessarily are similar to one another; rather a group exists when the people in it realize that their individual fate depends on the fate of the groups as a whole. As he puts it: "it is not similarity or dissimilarity of individuals that constitute a group, but interdependence of fate". The above views also corroborate with the views of the researcher.

Forsyth (1990) said that people join groups to achieve extrinsic goals, which they would be unable to achieve individually. According to Forsyth, the sharing of common goals is one of the strongest unifying factors within groups, and it motivates individual group members to behave in ways that result in the groups successful goal completion. The above view is relevant with the situation in the studied beels. It is not possible for any individual to derive any benefit from the resources and hence the platform under a group was the only means to achieve the goal *i.e.*, ensuring access rights to the resource.

It may also be pointed out that in 1996 there were 136 male members in Hamil beel and in 2000 it rose to 141. During the period of 97-98 a few members expressed their unwillingness to continue with the activities and therefore dropped their names. However, looking at the benefit the rest of the members derived from fisheries activities in 1999 they again joined the groups. It was possible because of flexibility adopted by the groups. This flexibility was due to the strong fellow feeling for their community members. The same is attributed for women groups too. Initially there number was 38 during joining the groups, 3 members dropped in 1998 and again joined in 1999 to make the total to 44 as on March, 2000. In Rajdhala beel there was no women group up to February 1998. This might have been for the reason that the women were not simply interested because they did not have any access to the water body. Their number however rose from 31 in 1998 to 37 in 2000. While mobilizing occupational

groups, most supportive agencies also organize women groups with equal emphasis on the assumption that sustainable changes cannot be brought about by ignoring the contribution of half of the total population (Costa, 1999). In this premise it was therefore pertinent to bring women to the threshold of the development initiative.

In addition to the above aspect, the figure indicates that there has been some exit cases of some members. The researcher also tried to find out the reasons as why some members had to leave the groups. The researcher during the process of the identification took note of the group meeting resolutions especially in those groups from which some members left. The finding is that since the groups are small institutions and run on the basis of consensus, the activities are guided by group bylaws. Every member of the groups is expected to abide by the bylaws. He/s had to comply with the decisions of the group. This was necessary for the proper functioning of the groups, which has been categorically emphasized since the formation of the groups. It is also assumed that some members did have a strong feeling of insecurity, especially in view of the volatile situation at the Rajdhala beel. The researcher can conclude it by saying that those members who could not comply with the decisions and also who did not participate in the activities undertaken by the groups had to leave, although there might be cases that some members opted to stay out of this process because of intimidation from the vested quarter. It is therefore evident that even if some members have left the groups, the purpose for the existence of the groups has not been compromised. It manifests the maturity level of the group members that has been developed over the years.

As per the work plan, each of the organized groups sits regularly in routine meetings once in a week. Besides normal business matters, *viz.* follow-up of decisions of the last meeting, reviewing of group activities, savings collection, financial statement, each group takes up an issue of their concern for educational discussion. The routine group meeting therefore, generally held for three major purposes, *viz.* to review decisions and activities of the last meeting, to plan activities for the period up to the next meeting and to take up the issue of resource management. This particular area is their main concern and for this reason they have converged in a group. The meetings of the groups and the discussion are the pillars and sources of inner strength of the whole process. In other words, in this dialogue-process each one shares his/her life experiences and observations, which are the real learning for one another. One encourages another and all members of a group to continuously learn from each group and also from outside or other groups' experience. This dialogue-process makes them a small 'dialogical critical cell', which gradually develops its skills of thought and articulation the group process. The researcher had one critical observation during the formation and functioning of the women groups. Holding regular meeting was a challenging event for them.

In the beginning they held meetings in someone's house, as they had no other place to assemble. This was also for the fact that the women first of all did not want to expose their unity for fear of reprisal. Once they sensed that their mobility is no longer a threat they started to assemble in the Community Center to hold meetings. This proved that they were also discreet and met the threat/intimidation in a very well planned manner.

As stated in the preceding paragraph, there are number of purposes for holding the group meetings. The meeting played a central role in defining group activities. In the group meeting decisions were taken as which member should be selected for what type of training. Who are the members that would help the BMC for stocking, or who would go for guarding duty at what frequency. They would also decide their specific roles during harvesting time. Besides, they would also decide the savings deposit in the bank and would entrust the responsibility to someone particular for a period of time to assist the group cashier. It therefore appeared that holding of group meetings in an organized and timely manner was an area of utmost importance as all activity plans were discussed and decided in the meetings.

It is widely perceived today that the main cause of endemic poverty and massive assetlessness of the majority population of a society is their powerlessness—the power of thought, articulation and institution building. In other words, poverty is synonymous with powerlessness of the poor and the marginalized. Thus, the powerless people themselves need to be empowered. Group meetings are therefore the pivot of their development initiative and are a continuous educational process for creating critical awareness among the poor about their actual condition and also their capacity to analyze the major causes of their problems. But this awareness is not individual awareness only; it is also group awareness with the view of creating a group or a community response to the situation.

6.1.3 Savings

This process showed remarkable change in their attitude. Once the process of capital build-up progressed, the group members started sensing the ownership feeling on the project. The activities started to gain momentum. Confidence of the group members grew high and they were convinced more than before that it is possible for them to work together for something better that had never happened in their life.

The poor are not unproductive. In truth they are relatively more productive segment of the population but unfortunately the fruits of their labor are usurped by the better-off segment of the population through economic, social and political manipulations. All these manipulations

find their strength in the control over financial resources. “If the control over financial resources can be loosened, the poor can at the very least begin to enjoy some fruits of their labor, expand their economic base, live their lives with dignity and look forward to building better lives for themselves as mentioned by Yunus (1983) in his paper on Group-based savings and credit for the rural poor.

In theoretical discussions, savers (lenders) and borrowers are usually imagined as two separate groups of people. Savers stash away their savings in the bank; the borrowers go to the bank and borrow the savings of others at a price. Not much attention is given to the fact that a saver himself can be an investor. Any small savings can be ploughed back into investment at any time.

The multiplier effect of investment can be vividly demonstrated in a credit program for the poor through the continuous expansion of their economic base as incomes rise with additional investments through borrowing. The vicious cycle of “low income → low saving → low investment → low income” can be broken by injecting credit in the cycle: “credit more → income more → savings more → investment more → income more”.

Group savings can have a major impact in the overall functioning of a group. These are:

- It imposes a discipline on the group members in developing a savings habit, which was not there before.
- Savings enhance self-confidence. Being a non-saver, an individual in a group find it a great source of encouragement to become a habitual saver.
- Savings cover normal business risks, seasonal variations in income, natural calamities like flood, famine, cyclone, draught, disease and political disturbances. Members of the group can undertake riskier decisions because they find some cushion in the savings.
- Group savings of the poor can demonstrate that their number is a great source of strength to themselves and to the nation. Even if each poor person saves a very small amount each week regularly, it adds up into an unbelievable large amount.

The result showed that savings by the groups were a laudable achievement by the communities in both the beels under the auspices of CBFM project. It has been observed that saving services that provided the saver with security, convenience, liquidity and returns, represented a crucial financial service for low-income clients (Robinson, 1995). The objective of savings was for two purposes. First this amount was meant to meet the urgent requirement, for which the group members do not have any other means and secondly, this money would be used for

cost sharing (stocking, lease fee, IGP). With the accumulation of savings the interest of the members were increased as better economic condition of individual members would ultimately lead towards the institutional sustainability. It was recorded that the attendance in the group meetings rose with the gradual accumulation of the thrift savings. Therefore there was a direct relation between the capital growth and group dynamism. Data from the group record shows that in 1996 when the groups started functioning the saving rate was low than that of the rate recorded in 1997-98. Two particular reasons could be attributed for this. With the gradual functioning of the groups the confidence level of the members rose to a great extent and they started getting some momentum by looking to the fact that their small money can actually do something big. With such level of confidence they started to invest on different types of IGPs including fisheries activities. With the positive results of their efforts, they found it worth to save more than what they thought before. In 1998 Hamil beel groups saved an amount of Tk. 13,110 (Tk. 96/member) and Rajdhala beel groups saved Tk. 30,216 (Tk. 321/member). The rate of savings by Rajdhala beel groups was much higher than that of Hamil beel groups. In 1999-2000 (up to April) deposit by Hamil beel groups was Tk. 14,704 (Tk. 85/member). But the total deposit has been decreased from the pervious year. This was due to the fact that the group started the process of cost sharing from their savings. Moreover, the groups also contributed towards the matching grant for the purchase of land and construction of the community center.

As discussed above, the savings rate of Rajdhala beel groups was higher. This was not the fact that the economic condition of the groups of Rajdhala was better than that of Hamil beel groups. The researcher, while interacted with the groups found that the groups somehow had to save at a higher rate because they understood that they would need more money for the resource protection and Rajdhala beel is bigger, so is the lease money. Therefore, they had little choice but deposited more amounts even if that was burdensome for them.

To support the activities of the Beel Management Committee contribution from the groups was essential. Although the contribution was meager but when accumulated it was a sizable amount. For individual members, this meager amount was even harder for them to manage although the purpose was for a better reason.

From the group records it was evident that savings was low and irregular during the period of June to August and high and regular during the period of November to February. The attributing reasons are that during the period of June to August because the fishers do not derive any income from fishery and at the same time they had to undergo cost sharing measures for fingerling procurement. The groups enjoy relatively better time during

November to February months as this is the harvesting time and individual income of the members are augmented so they were able to deposit savings at a higher rate in increased frequency.

6.1.4 Adult literacy

Education, either formal or informal is a means to fight vulnerability and provide prospects of self-help. From the beginning of the project it was continuously propagated that an illiterate person with no formal education can learn much through informal means.

Groups organized in both the communities under CBFM project had no idea on community organization and the purpose or function of such an organization. Initially it was a difficult task for Caritas field staff to bring them into some kind of discipline. Bringing people for attending adult literacy courses had to go through a series of motivational approach. The groups were made to understand that “they have to manage their own resources” and therefore they must know how to keep the accounts, read the books or even write the group resolutions. If they depend on outsiders to do these tasks, then there is every chance that the vested group of people might deceive them. This prompted them to enroll into the course, which they thought is a necessity for them. Because of high percentage in attendance in the classes, it was evident that the groups found the usefulness of the course.

The researcher during the field study attended in a number of courses. The process of imparting the lessons has also been observed and it was also possible to make a comparison with the status of the group members ability before the course was introduced and with the situation after the completion of the course. Following up the impact of such course, it was interesting to find that the majority of the groups were able to maintain their accounts and writing group resolutions. It may however be mentioned that after having completed a course it is not fully possible to comprehend all the necessary techniques but some progress is possible. Previously they would fully depend on the assistance from Caritas field workers to do these jobs, which is being done by them now.

6.1.5 Training

To be successful, the people involved in resource management, needs operational, technical, social, financial, economic and management skills. These measures will only be achieved through training either in formal or a non-formal way. Costa (1999) observed that the supportive agencies consider training as direct investment in people to help create

motivational awareness of the members and develop their capability for greater participation and initiatives by the members to bring required changes.

From tables 5.3 and 5.4 it would be seen that within the short span of the project period a good number of trainings have been organized and the participation is higher than that was expected. The table also shows that one member had received a number of trainings. It is interesting to note that more Rajdhala beel group members have received skill development training (91.6%) compared to Hamil beel groups, although only 4 courses were arranged compared to 12 in Hamil beel. This was due to the fact that Hamil beel group members were already engaged in different types of IGPs, especially in fisheries related activities even before the CBFM project started. So, they were a step ahead in this respect. But in Rajdhala beel, the beneficiaries were mostly engaged in carrying out specific tasks as required by the leaseholder. Neither they had the capacity nor there were any scopes for them to embark upon any scheme on their own. Therefore they were more interested to acquire new skills.

Emphasis was given on the aspect of leadership development and on enhanced management capacity. As discussed in the preceding section, leadership development and management capacity are the most crucial areas for resource management. The group members were also convinced of the fact that Caritas will assist them during the build-up process and eventually they will have to be the main actors. Moreover, for the proper functioning of the BMC, quality leadership was indispensable. Hoggarth *et. al.*, (1999) pointed out that “fisheries management need people with skills in many areas, from technical skills for the assessment of the fishery, through to social and management skills for encouraging co-operation and reducing conflicts”. Training programs designed for CBFM beneficiaries catered to the above expectation. Awareness building measures helped in mitigating the conflicts besides helping the community in understanding their situation while skill development trainings enhanced their management capacity. Pomeroy (1994) by quoting Mary Racelis affirmed that people who are organized, aware of their rights and ready to exercise them, and partners in the planning and implementation of resource management systems, can bring about sustainable development.

6.1.6 Exchange visit

It is perceived that by looking at the initiative of others, and if such initiative proves to be successful, one can easily gain the confidence of becoming equally successful if such initiative is similar. Similarly, by sharing about the experience of one's effort with others also could add value to the experience *vis a vis* the initiative.

Immediate outcome of the exposure program was that the confidence level of the members grew to a great height. For the first time they have started thinking positively on their ability in fulfilling the objectives of CBFM Project. BMC members of Banchte Sekha (BS) organized groups with both men and women. This gave a new impetus, especially to the women members that they can also be a part of the resource management team. The involvement of women members in the BMC also took away the myth that resource management is an area only to be looked after by men.

OLP-II has successfully demonstrated for the first time in Bangladesh that poor fishers are capable of 100% user group management of the resource and in development of culture based fishery with resultant enhancement in production (Middendorp and Balarin, 1996). In view of the success of OLP-II in ensuring co-management practice, it was crucial for BMC members to look into the inner dynamics of such a management system. Besides, experience of Caritas Bangladesh in organizing the rural community for formation of People Organizations under the auspices of its DEEDS project was also an area of further interaction. It was therefore particularly important for the group members to know in details the structure and key functioning areas of the people's organization.

From the exposures and looking at the functioning pattern of others, confusion that was prevalent regarding the role, structure, areas of responsibility of BMC was further streamlined. Especially, regarding the tenure of BMC, the election process was very much befitting for the members. They have also been able to specifically look into the resource management aspect, in the areas of stocking, guarding, benefit distribution. They were convinced that the situation is quite similar to them and all these are applicable in their situation.

Besides enriching their (group members) knowledge bank on the crucial aspect of resource management, the intrinsic part of the program was to ensure the participation of the key stakeholders *i.e.*, the group members to the maximum possible extent. Because it was thought that without the wholehearted involvement of the community members the initiative would be futile.

6.2 Changes in social capital

6.2.1 Institution building – Beel management committee (BMC)

It is obvious that for sustainable use of any resources especially natural resources the participation of the resource users is a must. Such participation should also be ensured during

the planning and management of the resource. It is also important to look into the aspect of equitable distribution of the benefits that will be derived from the resource. However, since all the resource users cannot be involved in the management, therefore the need of an organization to cater to the interest of the users is essential. The larger the group, the more people who will want to have input, and the greater the chances for conflicts to arise which will inhibit the decision making process (McGoodwin, 1990). There are also ample evidence that when everyone have to give a decision, there is bound to be repercussions as everyone have the same authority for either accepting or negating a motion. Berks (1994) pointed out that "managers are turning to the view that the person who does the job knows it best" It is therefore axiomatic that decisions taken out of consensus are likely to be complied with.

As described in the process chapter that after organizing the community under different groups the initial purpose was addressed. After group formation the next course of action was to enhance their knowledge and expertise for resource management. Hoggarth *et. al.*, (1999) also subscribed to the above proposition by observing that Fisheries Management needs people with skills in many areas, from technical skills for the assessment of the fishery to social and management skills for encouraging cooperation and reducing conflicts.

The formation of BMCs was associated with certain tasks in the areas of fisheries management plan that includes revenue collection, harvesting, guarding, benefit distribution. All these have been done in a systematic manner keeping in mind the necessity of sustainable use of the resource. It may be pointed out that the function of BMC was rather smooth and hassle free in Hamil Beel, while in Rajdhala beel, it was a strenuous process, since the overall condition of Rajdhala beel was not that amiable compared to that of Hamil beel.

The BMCs introduced certain rules for conservation and augmentation of the resource. These include fish banning for a particular time of the year, use of selective fishing gears, acceptance of casual fishing for food for non-stocked species etc. Then, for protection measures, rotational guarding system was introduced by ensuring full participation of the resource community. Such guarding system involving community people was introduced for the first time through which guarding cost was minimized. Community based management is seen as an alternative and possibly improved approach for managing common property resources, such as fisheries (Kuperan *et. al.*, 1994). The increased legitimization of the regulatory agencies (BMCs) through community participation in the regulatory and management plans is expected to ensure better compliance and thus reduce management costs. Institution building of the poor is understood as the fundamental concern as well as a key to sustainable development and establishment of right of the poor (Costa, 1997). The process of institution

building through the functioning of BMCs was observed during the implementation of the rules devised for sustainable resource management in the beels.

Fisheries enhancement implies some form of interaction other than harvesting (Lorenzen, 2000). It provides an institutional change linked to enhancement that can empower resource users and improve their organizational capacity, leading to wider social benefits. Initially, the groups organized under CBFM project were isolated. A well-devised and comprehensive motivational plan, including training of different kinds was provided to the group members individually to enhance their individual skills.

A new and dynamic process was in the offing as the newly constituted BMC started functioning. BMCs took major operational decisions for the resource management. In 1997-98 the BMC was formed in Hamil beel for the second time. The election process was held in a more democratic way, as all the members were able to cast their vote in favor of their desired person/panel. In 1999 Hamil beel BMC observed that paddy farmers were engaged in fishing of the stocked species during the monsoon. Discussions were held but no solution was reached. Later they applied to the concerned authority to demarcate the beel. This is still pending. This might be an isolated event but gives a fair amount of idea about the strength of an institution. From this particular event it was also evident that the common interest, rather than any individual preference was served.

The Beel Management Committee (BMC) of Rajdhala was formed in 1997-98 incorporating representatives from 4 fisher groups. In November 1998 an election by secret ballot of all participants was held for the three posts. Participation was encouraging and new persons took the office of secretary and cashier while the post of the ex-president was reelected.

Once the BMCs were formed they became the pivots of all activities with regard to the resource management and also catered to look into other peripheral issues that concerns the community. In Rajdhala beel the BMC stocked fish by themselves and arranged rotational guarding. They have also arranged harvesting in a systematic manner ensuring active participation of all the members. The Profit was distributed equally to all 93 members @ Tk. 4,299 each. The BMC bought 10 decimal of land at the cost of Tk. 8,000 for the construction of a community center. From the contribution of the fishers BMC met the partial cost while Caritas met the rest. The BMCs, as part of their social responsibility had also carried out various activities not related to fishing. They assisted the community people in different forms *i.e.*, contributing for medical expenses, paying examination fees, funeral cost etc.

With the effective functioning of the BMCs the fishers of both Rajdhala and Hamil are now able to protect their resources from the outsiders, follow a regular fishing system and observe the closed fishing time. With regard to the equity, improvements have been recorded over the past period. With the progress of time BMCs somehow succeeded to install the required systems through consensus of the members. For example, all expenses for stocking, harvesting are conducted through BMCs. The lease money is paid to the respective Government department through BMCs by following all agreed formalities. These types of activities further helped the BMCs to further consolidate their position as functional and effective institutions. BMCs also developed a system to retain 20% of the income from fishery for future use. From this fund counterpart contribution are being met.

While the progress is laudable with regard to the functioning of the BMCs, it has not been a cakewalk by any means. There have been cases of resentment and uproar. Operation of BMC in Hamil beel has been threatened with the change in the management committee. Although democratic process has been followed for electing BMC members, it cannot be readily ascertained that the system is accepted by all unequivocally. It will be several years before the sustainability of the revised institutions and organizational framework including election system can be determined (Thompson and Shelly 1998). The researcher agrees to the above notion by admitting the fact that while the fishers made small changes to operating the rules over the years, they have not changed any constitutional rules orchestrated by the supporting agency, Caritas.

The intrinsic part of institution building process through the formation of BMCs evolved in the premise of ensuring the participation of the resource users. The researcher wishes to discuss and attempt to clarify conceptually the notion of 'participation' and to look at the central role the concept plays in development strategy. The word is defined with many shades of meaning. The International Glossary on Poverty (Gordon and Spicker, 1999) defines participation as referring primarily to the process of involvement in decision making. It is seen as both an empowering and educative process. They believe, for example, that the only way poor can overcome their difficulties is by directly participating in the process of development, including participating in the formulation of policy in development program implementation and sharing in their benefits. This participatory approach has the dual goal of promoting growth and equity while also ensuring the development of democratic processes in the grassroots.

Participation is more linked to tackling the structural causes of people's poverty (Oakley, 1995), rather than as yet another input into a development project. People are poor because they are excluded and have little influence upon the forces that affect their livelihoods.

Participation is part of the process whereby people seek to have some influence and gain access to the resources, which would help them sustain and improve their living standard.

The researcher would argue that the above interpretation is relevant to the expectations of all the stakeholders of CBFM project. The researcher is further convinced of the fact that the end result of participation of the beneficiaries of a development intervention must be associated with the assurance of their full and unhindered access over the resources, especially if their livelihood is significantly dependent on such resources. The researcher therefore concludes this discussion by saying that the functioning of the BMCs not only relates to the economic development of the fishers but also a conduit for integrating the community efforts both in terms of their economic and social advancement.

6.2.2 Local allies

It is widely perceived that development initiative, even if that is targeted for a particular section of a community must involve other group of people in the process. Supportive role of non-beneficiaries could add value to the initiative. In this proposition a forum composing other members of the community was formed in both the beels. Local allies were composed of people from different social/professional background, *i.e.*, teacher of a local educational institution, social workers, lawyer, local government officials, and union council member. These groups of people were convinced that the initiative would help the poor strata of their community at the same would also protect the over-exploitation of the resources. Forming a forum of local allies was looked upon as a source *for collective action* by two sections of the community people with although their interest is not identical. Melluci (1995) considered collective action as a purposive orientation constructed by means of social relationship within a system of opportunities and constraints.

The researcher would relate to the situation of the groups (resource users) with the situation of an individual. The essence therefore is to buildup an alliance with those not directly linked with an initiative but play a supportive role in realizing the initiative pursued by the resource users. Merging of the interest of these two sections of people would then be the pivot for collective action. Wade (1987) defined that collective action is an action by more than one person directed towards the achievement of a common goal or the satisfaction of a common interest, *i.e.*, a goal or interest that cannot be obtained by an individual acting on his own.

To make a forum of local allies, Caritas had to adopt different strategies, as the situation of the beels were not similar. For example, in Hamil Beel, the community was quite positive on the

approach and they were also supportive to the initiative of the fishers. So, Caritas went through the normal motion and were able to build up a platform of some people who would extend all their support at their disposal to help the fishers establishing their rights over the resources. In Rajdhala beel, it was a different situation. There already existed a division within the local community. One quarter was aligned with the leaseholder and obviously looked after his interest. This particular group of people also had political influence. They apprehended that if the resource is allocated to the organized fisher groups then they are out of it. Although they did not enter into any kind of direct confrontation either with Caritas or the fishers, but always played behind the scene and continued to intimidate the fishers or even Caritas personnel. The local administration as well as the DoF officials had already a working relationship with the leaseholder over the years and thus had good rapport. It was therefore a strenuous process of confidence building measure with the officials. Fisher groups of Rajdhala beel were continuously fed with the idea that if Hamil beel groups could achieve this, why they could not?

Perseverance paid off at last. Good cause had the moral victory over the evil design. The situation afterwards changed dramatically. The Union Parishad Chairman, who never bothered to talk to these groups of people, took every opportunity to visit them and listened patiently to their needs. Attitudinal change has also been observed. Previously the TNO, DFO, limited their visits up to the resource level only. But from then on, they started to go to the user level. It was also encouraging to see that for the first time planning meetings were held in the community centers built by the fishers. In resolving of the disputes and difficulties arose from the allocation of the resources to the resource users, the supportive role of the local allies played a great part. The researcher observed that in complex situation unflinching support of the local allies helped in overcoming the problematic circumstances.

6.3 Changes in physical capital

6.3.1 Community center

The community needed a place where they could meet and carry out their regular activities. From the program point of view, it was a positive development for a number of reasons, *i.e.*, first of all they felt that they are the owners of a property, which exclusively belongs to them and secondly, with such a possession there has been a sense of added respectability. This was especially observable during various meetings, seminars that were organized in the community centers. As a matter of fact the social dignity of the people rose to a great height that gave them a new identity. All activities were planned and carried out from the centers. Ownership

over a property helped in boosting the confidence of the community people and it became a milestone in their quest for development.

6.3.2 Development of nursery pond

This was one of the steps the community had taken by looking at the necessity of having nursery ponds of their own. The experience of purchasing fingerlings from outside prompted them to think otherwise. With gradual development of skills through various trainings and by interacting with others they could decide about a tangible option. During 1996-97 it was experienced that by carrying fingerlings from distant places mortality was very high. Initiative was there from the beginning with regard to address the above problems and how to make the fingerlings available at close proximity to the beel and where BMCs can have the control, which would ultimately contribute to the production enhancement. Two initiatives were taken *i.e.*, to develop the skills of the fishers in nursery management and to explore the possibility of finding ponds which could be taken on lease or purchase for fingerling production. Although it was established in 1997, but due to lack of technical know how they did not get the expected result. Most of the fingerlings were bought from outside in 1997. The fishers were then trained on nurturing technology and in 1998 maximum fingerlings were supplied from the nursery ponds.

6.4 Changes in financial capital

6.4.1 Lease arrangements

It is widely perceived that public water bodies are one of the revenue earning sources of the Government. Any possession over such resources, either by any individual or by any organization should therefore be ready to pay the revenue as determined by the Government. However, an initiative like CBFM that envisages bringing about tangible benefit in the livelihood of the fisher community by appropriating the resources, then the matter of revenue earning should be the secondary objective.

Scanning through the historical perspective of leasing out the public water bodies it was found that in 1950, the then Department of Revenue of Government of East Bengal, took upon itself the responsibility of management of *Jalmohals* through the collectors and District Magistrates. The management consisted only of leasing of *Jalmohals* to the highest bidder in open auction held at the district levels. Under the system the term of lease period was for three years for beels and oxbow lakes (Hossain *et. al.*, 1997). The Ministry of Land (MoL) in 1991 replaced

auctioning through a notification by a process of invitation of tenders thus abolishing the previous system. The new directives contained detailed directives on the procedure of lease settlement through invitation of tender "offering of bid in response to invitation of tenders for lease settlement of *Jalmohals*", which was restricted to the registered fisheries cooperative societies. The cooperative society who offers the highest bidding money was to be given the lease title provided the offered bid was at least 25% higher than that of previous year's lease value. This system also aimed at augmenting the revenue earning. It is commonly recognized that many registered fisheries cooperative societies act as the front organization for mohajans (moneylenders). As a result, ordinary members of such societies hardly benefits from such lease arrangements.

In Hamil beel, the cooperative was formed in 1972 by a few individuals, which continued upto 1987. This was done under the favorable context when leasing was not awarded to private individuals. The lease value was on a regular incremental system set by the MoL like in most of the water bodies in the country. Caritas joined NFMP in 1992 in support of government initiative for the development of the fishing community. During the NFMP period, licensed fishers paid license fee directly to DoF. In 1995, between the transitions period of NFMP and CBFM there has been some inconsistencies and due to lack of proper follow-up mismanagement in stocking, harvesting was witnessed. The situation went almost out of control due to the onrush of floodwater at that time. Following a quick response from Caritas in 1996 the situation started to improve and Caritas entered to work with CBFM project. Nevertheless, there was still some kind of uncertainty in securing access right (due to delay of transferring the beel from MoL to MoFL), the fishers did not pay revenue in 1996. In 1997 after the handover of the beel to DoF for CBFM project, fishers paid the revenue and secured their access in the beel. In two occasions when government appeared to favor open access in 1975 and 1995, the ex-leaseholder and other local influentials attempted to take the beel from the cooperative by weakening its control and by encouraging mass poaching and declaring that anyone could fish in the beel. But the combined resistance from the cooperative members thwarted this attempt.

In early 1999, there was another attempt to put the beel for public auction for 3-year lease by the newly established Dhanbari Pourosova. BMC of Hamil beel with the assistance from district administration, local government, DoF, and Caritas was able to stop the move by securing an injunction from the court.

For Rajdhala beel, it was leased out to 3-4 influential outsiders between the period of 1986-1997. The BMC of Rajdhala also faced obstacles due to tenure period. The lease period was

over at the end of Bengali year 1406 (April 1999). Accordingly, Deputy Commissioner (DC) of Netrokona floated tender for leasing out the beel. BMC of Rajdhala placed a petition to the district court arguing that they got the lease after five months of the lease period. During this period of stay order, the DC ordered the Assistant Commissioner (AC) Land of Purbadhala to collect revenue from the beel. This was again prevented and the BMC also filed suit against the DC and ADC (land) for having violated the court order. Finally, the MoL decided to hand over the beel to the present users under CBFM project for three years and ordered the DC to collect revenue @ 25% higher than the previous lease value. Though the rights over the beel were ensured but the exorbitant rate of increment disgruntled the fishers.

The objective of CBFM is to ensure the rights of the fisher community over the beels and by using the resources the community would bring an improvement in their livelihood. The lease fee therefore is a hindering factor to achieve the objective of the project. Exorbitant lease fees are likely to create a setback in the quest for community management in the beels (Hossain *et al.*, 1997). Mathematical calculation of lease fee guided by the policy does not match with production potential. It is also noted that while deciding the lease fee there has been no consideration on the nature of the water body. Being semi-closed in nature, these beels are susceptible to many risks from man made to natural. The floods of 1997-98 have had colossal effect. This factor has also not been considered while fixing the lease fees after the flood.

Leasing time and tenure are also the crucial elements in the context of sustainable community management, which would be vivid if the following scenario is analyzed. Before the introduction of CBFM, Hamil was under the control of Fisheries Cooperative. Although the community at large did not have the exclusive right over the resource, it was nevertheless conducive for application of some of the basic management tools such as stocking, harvesting etc. As a result, they were able to pay the lease money and stock the beel timely, ensuring following years production. But for Rajdhala beel community it was a contrasting situation. CBFM was initiated in 1996, but Rajdhala community got the possession of the beel in August, 1997 (5 months later than the stipulated period). Therefore, they could not do the stocking properly, as this was a time specific task. The harvest was naturally far from satisfactory and the community inflicted heavy loss.

The above shows that how important is the timing of the leasing. While the government revenue department was content with the lease fee, the community bore the burnt. The same is applicable for the leasing tenure. Government policies continue to seek revenues through periodic leasing (1-3 years) of fishing rights to the highest bidder, the system has discouraged long term investments in fisheries management, imposed unequal power structures that have

kept poor fishers at the mercy of leaseholders and money lenders and led to over exploitation of the resources. In a bid to recover the lease payment and other transaction costs, leaseholders allowed many fishermen into fisheries as long as they are willing to pay user fees plus monopoly rent (Ali and Islam, 1998).

Since the tenure is normally for a shorter period, the community is always under apprehension of losing the possession and thus refrains from carrying out any development initiative on the resource (Hossain, *et. al.*, 1997). It is therefore evident from the above discussion that there is a correlation between lease fee, lease time and tenure. As a matter of fact this is a chain and severing one part will make the other parts non-operational.

For arriving at the base value, calculation is made on the value of the previous lease and hardly the time or the tenural factor is considered. Ali (1997) observed that all activities of 1990s (TFP, ADB, IFAD, CBFM) appear to emphasize management of water bodies to earn a revenue income of government from the policy of land to increase *Jalmohals* rent by 25% or even 10%, in every year. It appeared that MoL has taken it for granted that nature will continue to make available living resources continuously. Revenue fixation remain in the hands of the Administration, who did not have much understanding on fish biology which affected production potential of the resource (Ali, 1997).

Unfortunately fisheries remain one of the least valued of the various uses of water and in many areas institutions making decisions on the allocation of water do not even consider fish (FAO, 1990). This is a view that is fully compatible with the mind-set of those responsible for looking after the entire gamut of lease arrangement of public water bodies.

The above presents a dismal picture on the whole approaches in the management of the fisheries sector in the country. While maximum attention is given for the revenue augmentation, the essential prerequisites are ignored.

6.4.2 Financial management for fisheries activities

For understanding financial management for fisheries activities it is important to analyze the cost that have been incurred and how such costing affected the return and vice versa. While details are available from the result chapter for the corresponding parameter, it is worth to understand some salient features. Major financial involvement was in two particular activities that is the lease fee and purchasing fingerlings for stocking. With regard to the lease fee, the community had hardly anything to do, as the leasing authority determines the same. But

regarding the fingerling supply, the communities of both the beels took measures to improve the situation. Both the communities had to depend to outsider suppliers for fingerlings. The quality was neither dependable nor the price was appropriate. Therefore they had to find an alternative as well a tangible solution to this problem. By having their own nursery ponds, the community ensured the supply of quality fingerlings and as evident from the result, the cost towards fingerlings purchase continued to decline over the years. This was a positive move by any standard and the result is obvious. For purchasing fingerlings huge cost was involved. By availing loans from Caritas and by putting their savings as matching grant the communities were able to meet the cost (Hossain, *et. al.*, 1998). Regarding marketing plan, the community took the initiative and marketed their own products thus avoided their dependency on the middlemen.

The community, as part of their management plan continued to search for ways and means to curtail the cost especially that are within their managing capacity. Community guarding was introduced. The cost was declining cost towards guarding (Alam, *et. al.*, 1997). Although the community had to incur some cost for hiring guards especially during the festivals, but major portion of expenses could be brought down. All these initiatives helped the communities in reducing the costs. With the breakout of Epizotic Ulcerative Syndrome (EUS) in both the beels, it was necessary to undergo some measures. In Hamil beel Caritas assisted for liming and in Rajdhala beel the community had to bear the cost partially in 1997 and 1998. It would be interesting to note that since the community did the harvesting duty no expenses were incurred on this account. Rajdhala community had to incur additional expenses towards paying court fees, as they had to fight legal battle for having access right to the beel. Although not directly linked with fisheries management, the community had to incur some expenses on account of social activities. These sectors have witnessed a rise from year to year. This was due to the fact that more profitability allowed them to be more responsive to the needs of the community. It would be seen from the above discussion that the community strived hard to minimize the cost by introducing certain management plan ultimately aiming at maximizing the profit and finally bringing benefit to the resource users.

6.4.3 Income generating project - Credit

It is axiomatic that for any production enhancement effort, some period of time has to be allowed for the product to grow to marketable size. This assumption is perhaps more applicable for products composed of natural resources. For beel fisheries, it is argued that after the stocking at least 3-4 months should be allowed for the fingerlings to attain growth.

From the point of CBFM, IGPs were regarded as a supplementary effort to their (the groups) regular profession. The poor have the natural tenacity to look diversified source of income, as they feel that no single income source would guarantee their normal livelihood. This proposition has also been subscribed by Hulme and Mosely (1997). They tend to manage the IGPs and looking to minimize risk, so that if one activity or income out of that activity fails, it only has a limited, manageable impact on total household income (Wright and Graham, 2000).

As stated above, the IGPs were provided to the groups for supplementing their household income and an alternative livelihood arrangement. This venture was of particular importance as during the fishing ban period, the fisher groups were left with no regular income, while they had to continue with their regular household expenditures. This arrangement was also important from refraining the groups to go to the moneylenders, which has been a tradition over the years. The group members were already in the process of capital build up through individual/group savings. This savings accumulation enabled them to meet the matching amount of money for the loans.

From the program point of view, the types of IGPs one would embark upon had to go through some scrutiny. It was meticulously observed that whether the types of IGPs are compatible with responsible fishing practices (in case of fishery related initiatives), or any harmful gear is used for the activity. The experience of the borrower for the intended project, was also an area of investigation. It would be noticed from tables on training, that most of the members had undergone skill development training. This manifests the tendency of the members to acquire sufficient knowledge on different skills so that they can successfully embark upon the venture. Besides equipping the poor with organizational and practical skills, supporting them with needed resources, infusing them with the confidence and the determination necessary for taking actions to improve both their social and economic lives (Hedrick-Wong and Kramsjo, 1997). IGPs provided to the groups did have close relevance of the above proposition.

From the records it was found that in case of individual members IGPs the amount has gone up with the progress of time. For example the rate of borrowing per member rose from Tk. 1,500 in 1996 to Tk. 6,000 in 2000. This shows the increase of capacity of the members over the period of time. It was noted that the members are better aware about the management of the IGPs, which was the result of training they have received in the particular field. Another data shows that the members can now maintain their accounts without any help of the project personnel. Situation has improved remarkably compared with the status in 1997-98. It was an impact of Adult Literacy course and training on simple Accounts Keeping, which was offered by the project.

6.5 Fish harvesting

The fish yield performance of Hamil and Rajdhala beel were found satisfactory during study period. Individually, fish production of Hamil beel was more satisfactory than to Rajdhala beel. It might be due to regular stocking of fingerlings, more or less closed water bodies and active management of BMC. Under stocked fish both endemic and exotic carps were cultured in the beels, viz. rohu, catla, and mrigal were under endemic carps, whereas silver carp, grass carp, common carp/mirror carp, etc. were under exotic carps. Alongside, both beels were endowed with diverse kinds of non-stocked indigenous fish diversity that played a vital role in production.

The table 5 g (Annex-A) showed that 793.6 kg/ha of fish harvested from Hamil beel in 1998 of which 553.1 kg from stocked and the remaining 240.5 kg/ha under non-stocked fish. On the other hand in the same year it was 275.0 kg/ha in Rajdhala beel in which harvesting from stoked fish was less (20.6 kg) than that of non-stocked. It was seen that Hamil beel was stocked with fingerlings from May to June 1998 and a total of 98,110 fingerlings were stocked (Table 5f, Annex-A). Not only that in addition 100 kg of common and mirror carps were released in the same beel resulted a good catch in the same year. On the contrary Rajdhala beel was poorly stocked in 1998, i.e. 3,036 ind/ha, whereas stocking rate of Hamil beel was 6,132 ind/ha.

Rajdhala beel came under community control in August 1998 and the beel was stocked in September. Sizable fingerlings were unavailable in the perspective of Bangladesh, thereby the beel was understocked and it was insufficient time to get marketable size resulted a poor catch of stocked fish. But the non-stocked fish gave a good catch.

Subsequently, the table 5g (Annex-A) showed that in 1998 and 1999 the total fish yield declined in comparison with 1998 in Hamil beel. There were some issues, which might be the causes for such events. Though the beel was stocked with desired number of fingerlings in 1998, the beel was affected by the flood of 1998 caused escaping of fish. In 1999, stocking rate was 2,963 ind/ha in Hamil beel and the weight of harvested fish was 685.4 kg/ha in 2000, which implied better catch than the previous year. This might be due to low stocking rate, which reduced food competition. Moreover, no natural calamities like flood or draught took place during that year. Management and guarding system also improved in the following years. Before the introduction of CBFM in Hamil beel, the beel was stocked with uncounted numbers of undersized fingerlings, which resulted poor development. Under CBFM, through

social and technical training, the fishers have become more conscious of the importance of knowing how many and what sizes of fingerlings are to be stocked.

In 1999, non-stocked fish production was higher than that of 1998 in Hamil beel, but in 2000 it was less. The reason behind the abundance of non-stocked fish than stocked fish in 1998 could be for the flood of 1998 caused escape of fish and it was not possible to restock the beel with desired number and size of fingerlings. This was due to scarcity of fingerlings and want of economical distress caused for flood. On the contrary, production of stocked fish was found increased in Rajdhala beel in 1999 compared to 1998. It is because the beel was then under community control and initiated affirmative steps to manage the beel. And in 1999, there was no flood or prolonged draught, but the scarcity of fingerlings prevailed into that region. In 2000, the yield was not satisfactory (306 kg/ha) in Rajdhala beel than in 1999 (472 kg/ha). The reason was that the leasing period of the beel ended in 1999 and because of uncertainty in getting further leases, the community did not feel confident for further stocking. Indeed, comparing to Hamil beel, Rajdhala beel was encountered some unexpected events both natural and man-made during study period that affected fish yield and livelihood of the community. Moreover, the beel is larger than Hamil beel, thus needed more sound management. In view of ecological aspect, the beel is also endowed with vast resources demand tremendous potentialities and the result attained from the Rajdhala beel was found a little unsatisfactory compared with other findings. BRAC/RDP (1999) reported fish production of some ox-bow lakes in Bangladesh was 370 kg/ha, which revealed the low production in comparison with the present study and also followed by Sungunan (1995) in the reservoirs of Uttar Pradesh, India and CIFRI (1997). Again CIFRI (2000) showed the highest fish yield ranged 1,060 to 1,245 kg/ha/yr, which is reflected by the study and in some managed closed beels, the fish yield ranged 1,922-3,262 kg/ha/yr which is far away from the present findings. The fish yield status of the studied beels could be compared with the national production of ox-bow lakes, beels and Kaptai lake, where DoF (2001) reported fish yield of those waterbodies were 693 kg/ha, 653 kg/ha and 102 kg/ha respectively. These findings are almost similar to the findings of the studied beels, although some beels under DoF managed with improved methods like application of lime, fertilizers and feed. But there was no use of liming, fertilizing and feeding in the studied beels. So, the production attained in the study period by far more acceptable in conformity with other findings presented.

Both Hamil and Rajdhala beels are blessed with a vast number of naturally dwelled fish as well as these water bodies also endowed with moderate aquatic flora (Table 5e, Annex-A) made a congenial environment for fish living and the study expressed the same. Hamil beel took care of over 38 naturally dwelled fish and 8 stocked fish. On the contrary, Rajdhala

abounded with 35 naturally dwelled fish and 10 stocked fish (Table 5d, Annex-A). Of the stocked fish catla, mrigal, rohu, silver carp, grass carp, scale/mirror carp, etc. were dominant, whereas Indian river shade, barbs, common pony fish, mola carplet, catfishes, snake headed fish, etc were prominent under non-stocked fish. In 1972, both the beels were occupied a promising fish diversity and their abundance, whereas in 1997 it became declined and many fish species had been about to extinct. In 2000, the fish productivity both non-stocked indigenous and stocked increased significantly.

Among the stocked fish common carp yielded the highest (173 kg/ha) followed by mrigal (152 kg/ha), catla (146.3 kg/ha), silver carp (92.9 kg/ha), rohu (70.4 kg/ha), grass carp (28.8 kg/ha) and so forth respectively. The result highlighted the good productivity of catla than silver carp. Getting experienced and found promising productivity of catla in 1998, community people emphasized in stocking catla than silver carp in the following years. In the following year the productivity of silver carp was not so noticeable, therefore limited number of silver carp was stocked with a view to mitigate competition with Indian river shad. From the study it is assumed that severe food competition was found between Indian river shade (*Gudusia chapra*) and silver carp in Hamil beel. Because the productivity of Indian river shade was promising than silver carp.

This finding is in conformity with the result of Hossain *et. al.*, (1997), who reported Indian river shade is a strongly filter feeding fish and heavily compete for food with catla and rohu and in carps polyculture system Indian river shad reduces the net production at 47.49%. As the beel was naturally managed, *i.e.*, there was no application of fertilizer, the productivity of phytoplankton was not likely up to the mark required, on which silver carp mainly depended. On the other hand catla could avail both phytoplankton and zooplankton and grew well. In case of mrigal and common carp their growth were apparently found parallel during the study. In this regard, researcher observed that stocking was done considering feeding habit of fish and food niche of beels as natural food was only the source of fish nutrition and survival. This was also due to productivity of plankton and benthos and their food selectivity. CIFRI (1997) reported silver carp could be stocked safely in beels along with catla and silver carp has lesser chance to dominate over domestic species and silver carp did not considerably influence catla production. All good productivity might be due to favorable condition of physico-chemical parameters of water and soil, abundances of biotic community and over all better management of BMC. The present productivity is dominated with major carps both exotic and endemic followed by CIFRI (2000).

Many non-stocked indigenous fish species, which were about to disappear from these beels, exhibited their survivability as well as they became increased in stock. These fishes consist mainly minor carps, minor barbs, minnows, mullets, pipe fishes, loaches, murels, and other naturally occurring group of fishes. The increment was due to establishment of fish sanctuary, and obeyed rules of fishing set by the BMC.

Total fish yield of Hamil beel was 793.6 kg/ha in 1998, 782.8 kg/ha in 1999 and 685.4 kg/ha in 2000. Under the yield a significant portion was measured as non-stocked fish, *i.e.*, 240.5, 331.9 and 196.9 kg/ha respectively indicates Hamil beel with a promising diversity of naturally dwelled fish.

On the contrary, Rajdhala beel produced 275 kg/ha of fish (stocked 20.6 kg. and non-stocked 254.0 kg.) in 1998, followed by 471.9 (stocked-297.3 kg. and non-stocked 174.6 kg.) in 1999 and 305.9 kg/ha in 2000 where stocked fish was 156.5 kg. and non-stocked 149.4 kg. revealed good productivity of non-stocked indigenous fishes.

In 1998, the dominant native fish fauna was giant river catfish, which was 32% of the total catch by weight in Hamil beel, on the other hand Indian river shad was the dominant in Rajdhala beel (85%). In 1999, Indian river shad was found dominant in the both of beels followed by 2000 in Hamil beel, but pony fish (55%) in Rajdhala. CIFRI (2000) reported that in some beels of West Bengal, India minor carps, and other non-stocked fish like *Gudusia chapra* (Indian river shad) dominated the catch that matched the present study.

The table 5d (Annex-A) showed some native fish was found few in number in Hamil beel in 1997, but it became very common in 2000. Some of these fish are: banded snakehead, spotfin, rosy barb, ticto barb, Indian river shad, mola carplet, freshwater garfish, giant river catfish, tengra mystus, gangetic mystus, pabdah, catfish, magur, stinging catfish, climbing perch, striped gourami, dwarf gourami, tank goby, etc. In this regard, sanctuary and community management may contribute much. Different scenarios were found that some fish were few in 1997 and not found in 2000 in Hamil beel like olive barb, cotio, aor, gulsha-tengra, Indian potasi, ocellated puffer fish, mottled nandus, corsula mullet, humped leatherback, grey featherback, etc. Some native fish were found very few in 2000, like freshwater shark which was few in 1997. This might be due to having no proper connecting channel with the beel to other open waterbodies through which wild fish could be entered or limited stock to breed.

Similarly, in Rajdhala beel population density of many native fish increased (Table 5d, Annex-A). Some of these fish were: mottled nandus, common pony fish, spotfin, rosy barb, Indian river shade, tengra mystus, dwarf gourami, tank goby, etc. Most interesting matter is mottled nandus, which was about to extinct in Hamil beel, whereas it was very common in Rajdhala beel. Wrestling halfbeak, long whiskered catfish, Indian chaka, humped leatherback, day's mystus, olive barb, mola caplet, large razorbelly minnow, etc. were mostly not found in Rajdhala beel.

6.6 Physico-chemical properties of water

Among the physico-chemical factors of water temperature, transparency, depth, pH, dissolve oxygen, free carbon dioxide, total hardness, total alkalinity, ammonia, and nitrite were considered in the present study. An attempt was made to find the ranges of these factors of the beels under fish culture system. The rainfall, total hours of sunshine, pH, temperature and transparency of water had significant combined effect upon the abundance and growth of various species of phytoplankton, zooplankton and benthos (Ali, 1985). The range of **water temperature** was lower in winter and gradually increased towards summer. The pattern of fluctuation was almost similar in all the treatments of the two beels in 1998, 1999 and 2000. It implies that role of seasonal change was more prominent than the inputs applied in changing water temperature (Ahmed, 1993). Odum (1953) described water temperature as one of the major limiting factors of the aquatic ecosystem. No other single factor than water temperature has so many profound influences and so many direct and indirect effect (Welch, 1952).

Banerjea (1967) observed that the water temperature generally depends upon climate, sunlight and depth. The results obtained in the study agree with their observation. Low water temperature was recorded 21.7°C at Hamil beel and 22.3°C at Rajdhala beel in winter and high in summer 31.7°C and 30.0°C respectively. The water temperature of Hamil beel in summer was higher than that of Rajdhala beel. It might be due to less availability of aquatic weeds than Rajdhala beel. Similar result was also found by Rahman (2000) and Islam (1999) from the same beels. More or less similar finding was also observed by Dewan (1973) from tropical fresh water pond and by Ahmed (1993) in pond system. CIFRI (1997) reported water temperature of Aliyar reservoir, India ranged 21.2-32.5 °C in 1997, 14-26 °C in 2000 in some beels of Assam, and 17.5-35.5°C in some beels of West Bengal, where abundances of aquatic weeds was very high might result low range of water temperature. The present findings are also supported by Cagauan (2001) and Hossain *et al.*, (1996). Hossain (1992) reported water temperature 32°C is suitable for juvenile and onward, 31-33°C is disturbing temperature and

34-36°C is lethal for fish, which indicate that the range of water temperature observed in two beels during study period was in favor of culture system.

The **water transparency** was found more or less within in the suitable range for culture system. In most cases Rajdhala beel was reported higher transparency than Hamil beel, due to low production of plankton.

In 1998, maximum transparency was recorded in July at Hamil beel, subsequently it became lower in May in 1999 and continued to 2000 indicates good productivity of zoo and phytoplankton. On the other hand, in 1998, transparency ranged within 35-45 cm at Rajdhala beel, in 1999 and 2000 it was upto 85 cm indicating low water productivity in comparison with Hamil beel. Use of insecticides or pesticides in the crop fields and low depth water in winter season might be the cause behind of it. Certainly, low range of transparency at Hamil beel indicates good biotic productivity as well as good management of BMC in comparison to Rajdhala beel.

Reid (1964) reported that the transparency of a waterbody affected by several factors such as concentration of phytoplankton, suspended organic matter, latitude, season, the angle of intensity of entering light which was also supported by Hutchinson (1957), Amarasinghe *et al.*, (1983), Khan and Siddiqui (1974). In the present study the water transparency values indicating that both the beels are unproductive when compared with the pond transparency as stated by Wahab *et al.*, (1994), where they reported that the transparency of productive water bodies should be 40 cm or less. In view of water productivity the present findings are better than those of CIFRI (1997, 2000) where transparency was reported 108.0-182.0 cm at Aliyar reservoir and 11-103 cm in some beels at Assam and 12-232 cm in some beels of West Bengal, India. The findings (SD value of transparency 76.40 cm $\pm$ 3.86.) have drawn by Rahman (2000) from Rajdhala beel were in favor of the study.

Water depth is a factor that affects other factors, such as water temperature, dissolved oxygen, CO₂, pH, etc. Water body should not be shallower than 1 m or deeper than 5 m and optimum depth should be 2 m. During the flood of 1998, both Hamil and Rajdhala beels were flooded and the highest depth was recorded. During winter/dry season, the depth of water was low and created water turbidity. In terms of this Hamil beel was more affected than Rajdhala beel. The average value water depth in of Hamil and Rajdhala beel 1.7 $\pm$ 0.49 and 4.5 $\pm$ 1.13 meter respectively that was supported with the findings of Ehsan *et al.*, (1997), the work conducted at Chanda beel. Islam (1999) also mentioned almost the same water depth of Rajdhala beel.

The pH was found within alkaline range in both the two beels revealed the suitable range for aquaculture followed by Rahman (2000) who worked in Rajdhala beel. The study resulted pH values 7.7 ± 0.65 and 7.6 ± 0.32 in Hamil beel and Rajdhala beel respectively and found to vary 6.9 to 9.6 and showed a narrow range of fluctuation in 1998, 1999 and 2000.

The highest value (9.5) was recorded during May in 1998 at Hamil beel. Then the ranges were almost the same between 6.9 and 8.5 in the rest of years for both beels. According to Boyd (1982) the present ranges of values are suitable for aquaculture. pH more than 9.5 does not permit any CO₂ in water and so the primary production ceases and pH 11.0 causes fish mortality, pH less than 6.5 decreases appetite and growth of the fishes and reduces tolerance to toxic substances and the fishes fall easy prey to various diseases (Lloyd, 1992). Hossain (1992) reported pH value 6.5 to 9.0 is better for freshwater organisms and <6.5 enhance NH₃ and H₂S, affect more or less fish and other aquatic fauna, so the present finding was in favor of good fish yield. Hossain *et al.*, (1996) reported pH values of three floodplains, *i.e.*, Chanda beel 6.43 (June) to 7.21 (August); Halti beel 6.10 (June) to 7.10 (August-December); and in BSKB beel 6.06 (January) to 7.69 (May) which was also in favor of the present finding. Chowdhury and Mazumder (1981) reported water pH value of Kaptai Lake 5.31 to 6.32, which slightly defer from the present finding indicating slightly acidic media, while Ahmed *et al.* (1993) reported water pH of Kaptai Lake neutral to alkaline in nature (7.0-8.4) support the present study. The pH findings reported by CIFRI (1997, 2000) from different beels in India were in support of study and also added pH is more or less influenced by basin soil as well as aquatic weeds.

The average values of **dissolved oxygen** content in Hamil beel and Rajdhala beel during the study period were 5.7 ± 0.36 and 8.0 ± 1.19 respectively. It was observed that the average oxygen content was higher in Rajdhala beel and showed a diverse fluctuation.

On the other hand the dissolve oxygen content of Hamil beel was recorded within the range of 5.2 - 6.5 mg/l and showed a little fluctuation in 1998, 1999 and 2000. Aquatic weeds of Rajdhala beel affected the content of dissolve oxygen. High temperature recorded at Hamil beel might also affect the low content of dissolve oxygen of the beel. The diverse fluctuation of dissolve oxygen at Rajdhala beel might be due to decomposition of aquatic weeds. Hossain *et al.* (1996) reported the maximum dissolve oxygen content of 4.91 ppm. in Chanda beel in January, 6.09 ppm. in Halti beel in December and 6.09 in BSKB beel in May, while the minimum was 2.3 ppm. (April), 4.97 ppm. (March) and 3.17 p.p.m. in December respectively which differ the present finding.

They focused the dynamics in the dissolve oxygen was found to be influenced by the overall ecological situation in either beel and the areas in a particular, thus, areas covered with water hyacinth had lowest dissolve oxygen content having lowest rate of vertical fluctuation and areas covered with paddy and aquatic vegetation had the maximum dissolve oxygen in surface water and the minimum in the bottom. But in case of Rajdhala and Hamil beel there was a bit chance to occur the same owing to control management (BMC). Rahman (2000) who conducted a work at Rajdhala beel and naturally managed beel and also by CIFRI (1997, 2000) opined the same.

Dissolved oxygen is one of the primary factors in natural water as a regulator of metabolic process of plants and animals. Low oxygen content of water has great influence on the abundance and diversity of plankton and benthic fauna. Banerjee (1967) considered 5.0 to 7.0 mg/l dissolved oxygen content of water to be fair or good in respect of productivity, which also followed by Cagauan (2001). Rahman (1992) reported dissolve oxygen at levels of 3 ppm. or lower regarded as hazardous to lethal under stream and lake conditions; and that 5 ppm. or more of dissolve oxygen is better for freshwater fishes. Fishes can survive at low level of dissolve oxygen (1 ppm or less) for a few hours but not for long time. The concentration of dissolve oxygen becomes highest during afternoon to evening and lowest at dawn. When dissolve oxygen falls to harmful or lethal level (less than 3 ppm.) fishes show restlessness moving abnormal. Ahmed *et. al.*, (1993) showed dissolve oxygen concentration of Kaptai Lake 7.42 ± 0.90 at surface level while in bottom 5.4 to 7.5 mg/l, which was in conformity with the present result.

The average values of free **carbon dioxide** were in Hamil beel and Rajdhala beel 5.3 ± 1.69 and 5.2 ± 0.59 respectively, which is likely high in comparison with that of pond culture system. The study supported the study of Rahman (2000) on Rajdhala beel, and Ahmed *et. al.* (1993) on Kaptai Lake. The carbon dioxide values of Rajdhala beel were lower than Hamil beel. This might be due to decomposed aquatic weeds. High concentration of free carbon dioxide is due to release of carbon dioxide from the decomposition of organic matter and dead bodies of plant and animals and reduced photosynthesis is due to cloudy skies (Dewan, 1973). Lowest carbon dioxide content is due to intense photosynthetic activities. Hossain (1992) reported fish could tolerate 10 mg/l carbon dioxide and generally 4 mg/l present in pond water. CIFRI (1997, 2000) showed free carbon dioxide content of Aliyar reservoir 0 to 10 p.p.m; 0-16.0 mg/l of some beels of West Bengal and 1.0-19.6 mg/l of some beel in Assam with a mean value of 4.0 mg/l. did not support the study, in case of higher ranges, *i.e.* 10-19.6 mg/l. Lagler (1972) stated that the free carbon dioxide excess of 20 p.p.m. might be regarded harmful to

fish. Cagauan (2001) reported carbon dioxide content below 10 mg/l is suitable for fish culture.

Swarup and Singh (1979) reported the free carbon dioxide in water form carbonic acid resulting change in the pH as the hydrogen ions are set free after dissociation. Hynes (1970) reported the influx of carbon dioxide resulting from rainwater in the form of carbonic acid, lowered the pH. Sreenivasan (1992) noted free carbon dioxide is present even in the surface waters of soft and medium hard water reservoirs, but is absent in hard water lakes, which is not applicable to the present study. Considering the above statements, it may be concluded that the levels of free carbon dioxide in two beels were within the favorable limit.

The level of **hardness** content was found to be higher in Rajdhala beel than that of Hamil beel during the study period. The variation in two beels might be due to variation in photosynthetic activities of phytoplankton, which utilize free carbon dioxide and increased the calcium carbonate level. During May of 1998, the values were almost same and low (15-35 mg/l) of the two beels, but it gradually increased to 108 mg/l on September in the same year. Subsequently, it became gradually lower and fluctuated in the 1999 and 2000. Clark (1954) found more carbonate when free carbon dioxide was taken from water by photosynthesis. Similarly, Cagauan (2001) reported hardness >12.5 mg/l CaCO_3 as calcium hardness is suitable for fish culture. Islam (1999) showed water hardness of Rajdhala beel between 51.3 to 108.3 mg/l of CaCO_3 , while Rahman (2000) reported 85.50 to 89.50 mg/l. Chowdhury and Mazumder (1981) reported a narrow range of hardness (50.0-66.67 mg/l) from Kaptai Lake. Similarly, Ahmed *et. al.*, (1993) reported the values of hardness of the same lake 35.33 mg/l (August) to 54.72 mg/l (February) in 1988-89, while 47.6 mg/l (September) to 65.0 mg/l (January) in 1990 with no regular trend in fluctuations, which indicate that hardness of Hamil beel and Rajdhala beel is more or less positive for fish culture.

They also showed correlation of hardness with pH ($r=0.386$, $p<0.02$) and secchi disc transparency ($r=0.409$, $p<0.02$). CIFRI (1997) showed carbonate and bicarbonate alkalinity of Aliyar reservoir 0-14.0 and 16.0-58.0 p.p.m, which was less than the present result, whereas CIFRI (2000) showed hardness values of some beels of Assam 10.0 to 169.0 mg/l, which was in conformity with the present values.

The values of **alkalinity** of Hamil & Rajdhala beel were 48.4 ± 22.32 and 82.1 ± 23.47 respectively. In 1998, it increased upto 108.3 mg/l at Rajdhala beel, and 90 mg/l at Hamil beel. In 1999 its trends were directed mostly downward with random fluctuation. The values were always positive and the highest peak was recorded in 2000 at Rajdhala beel. Rao and Govind

(1964) reported waterbodies record dilution of alkalinity with the advent of rains and its increase with the decrease in water level. According to Alikuhni (1957) total alkalinity more than 100 ppm. should be present in highly productive water bodies. But according to Maris (1966) water bodies having total alkalinity 40 ppm. or more are considered more productive than water bodies of lower alkalinity. Similarly, Cagauan (2001) reported the congenial range of alkalinity 25-250 mg/l CaCO_3 for fish culture support the finding. Barrett (1953) reported total alkalinity values of over 80 mg/l indicate a lake to be nutrient rich and of hard water type and such waters often the best fish producers. From other study lake waters registering calcium carbonate below 24 mg/l are generally regarded as soft (Clegg 1974). So, it is clear that the beels are hard water type and good producers. Ahmed *et. al.*, (1993) reported the water alkalinity of Kaptai lake to be fluctuated between 33.5 (August) and 53.0 mg/l (March and April) in 1988-89, whereas it was 47.6 (March) and 71.0 mg/l (April 1990-91) supported the study, also by CIFRI (1997).

The mean value of **ammonia** concentration was 0.1 ± 0.17 and 0.2 ± 0.02 in Hamil beel and Rajdhala beel respectively. Unionized ammonia is toxic to lethal for fish and other aquatic organisms. A critical level less than 0.14 mg/l of ammonia has been recommended by Widdows (1985). Organic decomposition from dead aquatic vegetation might be one of the possible causes of higher value of ammonia in the studied beels. Islam (1999) showed the concentration of ammonia between 0.23 and 0.016 mg/l, where the minimum value was recorded in July 1998 and the range was 0.23-0.22 mg/l from December 1998 to April 1999 at Rajdhala beel waterbody, while Rahman (2000) showed 0.20 to 0.24 mg/l where average standard deviation value was $0.22 \text{ mg/l} \pm 0.01$ and favour the present result.

Nitrite, the partially reduced form of nitrate is usually present in insignificant quantities (Goldman and Horne, 1983). The study reported the range of nitrite between 0.0 and 0.1 mg/l and 0.0 and 0.2 mg at Hamil beel and Rajdhala beel respectively. The value found in Rajdhala beel was higher than that of Hamil beel, which might be due to decompose of aquatic weeds. The findings of nitrite were not significant recorded during the present investigation. Islam (1999) showed the concentration of nitrite at Rajdhala beel waterbody insignificant value ranged between 0.016 and 0.18 mg/l where the highest value was in the month of August 1998 and the minimum in June 1998. Zafar (1964) reported when the dead organic matter decomposes in water it forms complex proteins that get converted into nitrogenous organic matter and finally into nitrates by the bacterial activity. Cagauan (2001) reported the value of nitrite $<0.1 \text{ mg/l NO}_2\text{-N}$ is suitable for fish culture, which was in support of the study.

6.7 Plankton and productivity

Both qualitative and quantitative parameters of plankton were estimated during this study. Each plankton is directly or indirectly subjected to the complex of influences which changes with seasons and some effects might be made, some of which result in the quantitative changes, *i.e.*, increases or decreases of size of the population. Such variation in population might be due to the variation in nutrients and other favorable conditions of water during plankton production (Welch, 1952). During the present study, both phytoplankton and zooplankton was observed and a distinct fluctuation of planktonic population in different months was determined. The density of plankton was higher in Hamil beel than Rajdhala beel; abundance of zooplankton was found higher in Hamil beel than Rajdhala beel. The phytoplankton fauna was represented with different groups and cited here as order of dominancy in Hamil beel: Chlorophyceae>Bascillariophyceae>Cyanophyceae>Euglenophyceae. In Rajdhala beel: Cyanophyceae>Chlorophyceae>Bascillariophyceae>Euglenophyceae. Sultana (1997) observed the order of dominance was: Chlorophyceae>Cyanophyceae>Bascillariophyceae>Euglenophyceae. On the contrary zooplankton was represented by Rotifera, Copepoda, Cladocera, Ostracoda, Protozoa and Nauplii. In Hamil beel and Rajdhala beel the most dominant group was Rotifera. In both the beels the second and fifth dominant group was the Cladocera and Ostracoda respectively. In Hamil beel the third and the fourth dominant groups were Protozoa and Copepoda respectively. On the other hand in Rajdhala beel the third and the fourth were Copepoda and Protozoa respectively. The highest and lowest densities of zooplankton were in April during 2000 and October during 1998 in Hamil beel, and they were in July and September at Rajdhala beel. Chowdhury *et. al.*, (1989) reported Rotifer the dominant group (52%) followed by protozoan (16%) and ostracods (12%) in a fish pond.

Storms (1981) recorded maximum number of zooplankton in June and minimum in February in Quantico Creek and the adjacent Potomac rivers. The maximum production was observed in the warmer weather, the results of which can be compared with the observations, shown by Green (1960). During field observation it was found that the population of zooplankton was markedly low due to the algal bloom (Arora, 1966). Similarly Das and Bhuiyan (1974) found the maximum production in warmer month and minimum in August and January to February in some inland water of Dhaka city.

Watson and Carpenter (1974) showed peaks of zooplankton in the spring or summer months from the lakes Huron, Erie and Ontario, Canada solicited the study. Between the two major groups of plankton, the phytoplankton was found to dominate the zooplankton in pond

management (Ahmed 1993), which did not generally support the present study, but partly with the findings under Rajdhala beel, where phytoplankton dominated zooplankton. Bhowmick (1968) reported a bimodal pattern of plankton production in Kalyania fish farm ponds (West Bengal) observed the maximum occurring in monsoon and winter. The monsoon peak persisted till October and was invariably dominated by phytoplankton and the winter peak was dominated by zooplankton. CIFRI (2000) recorded plankton during winter (25 to 4658 u/l) were manifold higher than those enumerated during summer (281 to 40.836 u/l). This was due to unstable environment during monsoon months and of open beels. Ahmed *et al.* (1993) showed the highest occurrence of plankton in January (3313 ± 3781 no/l) followed by February (3294 ± 1026 no/l) and March (3283 ± 3224 no/l) differed with the study. They also added phytoplankton dominated over zooplankton and gradually increased with the decrease of zooplankton. Ali (1985) reported the peak abundance of phytoplankton in October and December respectively and endowed with blue green algae did not favor the findings. Chakrabarty *et al.* (1959) and Ayyapan and Gupta (1980) showed the direct correlation between zooplankton and phytoplankton, whereas Khan and Siddiqui (1974) showed an inverse relationship between zooplankton and phytoplankton.

Fishes were stocked in beels from the month of May every year. The plankton population density was gradually declined with yield of fishes. In Hamil beel, the highest peak of phytoplankton was in May in 1998, then it was gradually declined and in comparison with 1998 phytoplankton productivity of Hamil beel was less than those of 1999 and 2000. Overall, the phytoplankton abundance in the present study was less than that of zooplankton. Therefore, the yield of catla (138 kg/ha), a zooplanktophagus fish was higher than that of phytoplanktophagus fish, silver carp (66 kg/ha). This result was more apposite for Hamil beel. On the other hand Rajdhala beel was endowed with more or less aquatic weeds. For this, production of grass carp (herbivorous) was better than that of Hamil beel. There might have many causes behind the low concentration of phytoplankton in Hamil beel. Production of phytoplankton is dependable on phosphorus element, which may be dearth during the study period, and the value was not sampled.

Moreover, in comparison with Rajdhala beel Hamil beel was more or less free from organic nutrients and wastages affect the abundance of phosphorus. Davis (1955) pointed out that the abundance of zooplankton reduced the growth of phytoplankton and *vice-versa*, probably due to some toxic substances released by these organisms. The variables among the results of the different studies could arise from the difference in the nutrient status, chemical qualities of water and density of fish species stocked with.

The present study beels were stocked with various species of carps including silver carp, which mainly feed on phytoplankton, it was probable that the grazing by the carps have reduced the abundance of phytoplankton. Ameen *et. al.*, (1986) and Alam (1987) convincingly showed that stocking density of fish reduced the amount of phytoplankton in two ponds in Noakhali district. It was highest in May 1998, while it was lowest in January 99 in Hamil beel. CIFRI (2000) reported productivity in terms of phytoplankton density was poor in all beels of Assam, although low pH, transparency and conductivity are attributable to this, low plankton concentration, the predominant factor is the competition with macrophytes in gathering sunlight and nutrients. A winter peak abundance of phytoplankton was also noted by Govind (1963), which was not found during the present study.

6.8 Benthos and productivity

The existence of the **benthic fauna** was observed throughout the study periods, which indicates the productivity of beels. The production of benthic fauna varied from 300 to 2,706 ind/m² and 355 to 919 ind/m² . in Hamil beel and Rajdhala beel respectively during study period, which indicated Hamil beel was more benthos enriched water body than Rajdhala. Ahmed (1993) reported population density to be ranging from 631 to 2415/m² in pond system, Mustafa (19.. pl. from cite) recorded from 667 to 4110/m² and Murty *et. al.*, (1978) reported from 362 to 4231/m².

The West Bengal beels were blessed with benthos ranging from 90 to 13,238 no/m² and also sometimes 0 to 1763 organisms/m² (CIFRI, 2000). The data on benthic population obtained in our study more or less agreed with these records. Thienemann (1925) classified a lakebed producing between 1000-2000 ind/ m² as mesotrophic. On the basis of this classification Hamil beel could be placed as mesotrophic waterbed in nature. In Bangladesh no such attempts have been taken to classify the beels on the basis of availability of benthic organisms. The major groups of benthic fauna recorded from two beels during the study were mollusca, oligochaeta, and chironomidae. Most dominant group was mollusca followed by oligochaeta and chironomidae respectively. The population density of mollusca was recorded the highest in May of the 1999 and the lowest in May of the same year at Hamil beel. Oligochaetes and chironomids were also found dominance in May and January of the 1999 in Hamil beel. Oligochaetes were the second dominant group of the benthic fauna of the beels followed by Das *et. al.*, (1981), Ali *et. al.*, (1978, 1981) and Ahmed *et. al.*, (1991). Different sceneries on abundance of benthos observed in the reports solicited. Rahman (2000) reported the highest number of benthic fauna in December in Rajdhala beel with an average number 1270.01 ind/m² and the lowest 869.14 ind/m² during September respectively. Mondal and Moitra

(1976) recorded the highest density of benthos in summer. Patnaik (1971) reported the largest benthic population between October and December and the minimum during the monsoon. On the other hand Ahmed *et. al.*, (1993) recorded the minimum quantity of benthos in November (232 ind/m²) and maximum in January (746 ind/m²). Srivastava (1958, 1959) reported on the bottom fauna of some ponds of Lucknow, which exhibited seasonal fluctuations, its total volume being highest during monsoon months attributable to the dominance of mollusks and oligochaetes. Bhowmick (1968) reported that the volume of bottom organisms in ponds of the Kalyani fish farm in West Bengal showed a unimodal pattern of distribution during the year with a single broad peak spread over winter and early summer months (January to March) and a single trough during autumn (September to October). The winter-early summer peak was constituted mainly by chironomids.

However, in numerical abundance, benthic fauna, represented by oligochaetes and crustaceans, was at its peak abundance during monsoon. Eggstone (1931) observed the minimum abundance of benthic organisms in mid-summer and the maximum in mid-winter in Doglas Lake, USA. Moitra and Bhowmic (1968) observed the peak benthos in winter/early summer and tough in autumn. Gupta (1976) reported maximum densities of benthic organisms in January from Loni reservoir.

The study revealed that the population density of **benthic organisms** of the two beels was directly correlated with fish yield. Bottom feeder fishes like rohu, mrigal and scale carp/mirror carp feed on benthos as diet. The remarkable differentiation was found in these bottom feeder fish of two beels. In 1998, rohu, mrigal and scale carp/mirror carp yielded 70.4 kg, 59.8 kg and 173.4 kg per ha waterbody of Hamil beel, whereas it was only 0.4 kg, 0.5 kg and 2.6 kg in Rajdhala beel. Successively, in 1999, the production was 44.9 kg, 152 kg and 68.7 kg in Hamil beel followed by 29.5 kg, 29.7 kg and 15.7 kg in Rajdhala beel and more or less the same trend was found in 2000. The fish production data of Hamil beel implied that the beel was endowed with adequate benthos than that of Rajdhala beel, which was also agreed with benthos productivity of the two beels. CIFRI (1997) stated productivity of biotic communities like benthos and macrophytes are directly related to the abundance of organic matter and other morphometric characteristics of the reservoirs; lack of organic detritus in the reservoirs substratum as evidenced by the total absence of bottom biota and absence of macro-vegetation have affected establishment of bottom feeders like *Cirrhinus mrigala* and browsers like *Labeo rohita*.

The dominance of macrobenthos has been reported earlier by Das and Islam (1983) from tropical freshwater pond and Kumar and Mitra (1986) from oxbow lake. The probable cause

of the occurrence of these dominant groups of bottom fauna may be due to the favorable ecological condition for their growth. Bottom type and amount of bottom deposits exert a significant influence upon the occurrence of bottom organisms and their kinds. The characteristics of bottom deposits affect the nature and distribution of bottom fauna has been demonstrated by many authors. The result obtained from the study indicated the seasonal variation in the benthic population. Moore (1980) pointed out that the diversified physico-chemical conditions of the littoral zone should result in quantitatively diversified littoral fauna. The seasonal abundance of benthic fauna may be due to changes in temperature periodical changes of water level by the rain and floodwater incursion.

Rahman (2000) reported with respect to depth distribution the greatest number of benthic organisms found to be occurred in shallow (41.85%) depth which followed medium deep region (37.54%) and the deep region (20.61%) at Rajdhala beel and the average organism per m² was 1396.83, 1252.91 and 687.83 respectively for three depths. Stcliffe *et. al.*, (1981) stated that the reproductive biology and growth rate of benthic organisms increased with increasing of temperature reflected the result obtained from the study.

6.9 Towards sustainability

Sustainable development is to be looked upon more in terms of human needs than a trade-off between economic and biological systems. It is also important to see at what level sustainability is important (Redclift, 1990). Some distinctions are required to be measured because what is sustainable at one level may not be sustainable at another and vice versa.

One of the objectives of CBFM Project was to organize the communities and facilitate their efforts in establishing their right to access in the beels, support them in fisheries resource management, ensuring equitable distribution of benefits, improvement in livelihood practices and finally build up an institution that will cater to the interest of the community in the long run. It was envisaged that these systems would be practiced during the implementation phases of CBFM and would continue to exist even after the phasing out of the project. It was also envisaged that if the community is able to effectively handle their tasks in the above fields then the quest for sustainability would be effective. The researcher observed that systems that will have been required to ensure sustainability, have been set up and being practiced by the community under the supervision and guidance of the BMCs, although these are yet to be infallible. The proceedings have also been recorded and progress has also been measured at regular intervals.

Elements of sustainability: From the inception of the project, adequate attention has been laid on the development of areas on which the sustainability effort would be built upon. Awareness of the community has been a crucial issue. More aware the community people are, chances are better that they will treasure the initiative and work relentlessly to achieve it. **Organizing community** was the primary task, which has been done systematically. Most of the community people were able to grasp the concept of the initiative and expressed their willingness to participate. However, it was not possible to bring the entire community in the same platform, as the objectives of CBFM project were to organize the fishermen community only. This remained as a bottleneck and might develop some kind of conflicts, which has already been observed in Hamil beel. Once the organizing part was done then the process of **group formation** began. Groups were formed according to the pre-set criteria that were decided after the process of PRA/FGD. Then the group activities began with the regular meetings, savings generation. It was observed however, that the essence of group dynamics is still not there, although pursuing the common agenda has been well conceived. **Training** of the group members have been given due priority as it was thought that not only the members will be able to develop their skills, but also become articulate to press for the issue of accessing to the resources and addressing the contentious issues. Besides, from the training the need for **adult literacy** courses was surfaced out and the members were motivated to enroll in the adult literacy course. The attendance was commendable and the primary objective has been met. Simultaneously, rapport building process through the **Development Allies** continued and a platform of supportive forces has been established. But as usual, still there is a sizeable section of the community who do not harbor the idea of empowering the poor. These groups of people are powerful and have link-ups. Keeping them in abeyance and not taking them in confidence may breed animosity that may lead in jeopardizing the community cohesion.

Access to the resources has been ensured and the sense of possession of the resources brought about renewed prospect in the life of the community people. This helped in renewing their hope that with the progress of time they will be able to increase the benefit from the resources that will increase the chances to fight vulnerability. But mere access to the resource does not necessarily mean that everything has been achieved. High lease value, shorter tenure and delayed hand over would lead to less profit as there is a direct relationship between lease fee, tenure and production. Moreover, short tenure of leasing system obstructs the sense of ownership (Pomeroy, 1994).

Setting up an institution in the form of Beel Management Committee (BMC) was perhaps the most crucial event that has taken place during the life cycle of the project. BMCs have been able to restore some authority or power as such power is about the capacity to impose will on

others (Villarreal, 1992). However, this is not only about imposition of will but also to make a peaceful coexistence (Kaufman, 1997). But it may not be hassle free as exercising power is associated with resistance (Afsar, 1998). Sustainability effort pursued by the community through the CBFM project is also closely linked with the level of empowerment of the community, as it about collective community, and ultimately class conscientization (Craig and Mayo, 1995), to critically understand reality and ultimately to transform that reality. It is a starting point (Hall, 1992) and a continuous process. Through the enactment of BMCs the purpose of Institution Building have been responded. It is important to note that without the presence of an institution, every individual will act on their own and as a result there will be another chaotic situation (McGoodwin, 1990). Therefore, setting up of an institution as a regulatory body was very important to be able to exercise some power and have control of knowledge. All development work is to do with the control of knowledge (Cornwall, 1992) and if the underprivileged were able to control the sources of knowledge, the structures of existing power relations would be radically altered. But all these positive moves are still at a nascent stage and the conditions do not guarantee smooth continuity. However, in spite of some shortcomings, BMCs have been able to instill fisheries management plan and gradually responsible fishing practice has been developed.

The groups have been trained on different aspects of resource management and were also fed with the idea of cost-benefit of the initiative. *Nursery ponds* were developed for ensuring quality fingerlings supply and also to reduce costs; community *guarding, harvesting* was carried out under the system developed by the BMCs. The community needed a place from where they can carry out their day-to-day activities. *Community Center* built by the groups became the center of excellence. Establishing the system of equity in sharing the investment cost as well as sharing the benefits helped the community to understand precisely their responsibility as well as their privilege.

Building up the economic base of individual members and of the community in general has been a laudable effort. Increased rate of *savings* by undertaking of various *income generating* initiatives heightened their confidence on their own ability. The fishers are more aware now than before on the conservation measures, while augmenting fish production without disturbing the natural ecosystems. Fishers are now better informed about the harmful gears, best time for harvesting, and also the benefit of 'closed fishing season'. All these good practices are aimed at increasing the possibility of future sustainability of the initiative.

Many a good initiatives die prematurely because of lack of transparency. The accountability system for the functioning of group activity to the function of BMCs was developed is such a

way that each member of the community is aware of what is happening and how their interest is protected. From the resolution of the meetings it has been observed that reporting of progress on any of the actions have been regular and clarifications are given for not having achieved something that has been planned earlier. Having seen the effectiveness of the functioning of the areas as enumerated above, it gives an impression that the essential prerequisites for attaining sustainability of the initiative have been put in place. All these practice is a step towards reaching the long cherished goal of achieving sustainability, although a lot more need to be done before being certain about the initiative.

Role of *supporting institutions* is an added strength in the quest of sustainability. In this premise the objectives of CBFM Project could be put as a referral point. During the implementation period the roles of the supportive agencies have been proved very crucial in streamlining the activities of the undertaking. It has also been observed that all the supporting agencies such as the donor, MOL, MoFL, DoF, NGO and Research Organizations extended their unflinching support in the endeavor of the community. This support would greatly facilitate the effort of the community in furthering their activities and would play a crucial part in the effort of the community in achieving sustainability.

A set of minimum conditions is needed for development to be sustainable (Pearce *et. al.*, 1990). It ranges from increase in real income to fairer distribution of income. It may be pointed out that the achievements made so far are a step towards arriving at those minimum conditions.

The areas of sustainability, in view of CBFM effort should be seen and analyzed from following three different perspectives *i.e.*, group *vis-à-vis* BMCs dynamism or efficiency, equity and continuity. While all the above three areas are equally important, it is argued that efficient functioning of the BMCs are the cornerstone of all the endeavors.

Sustainability takes time and it is not a process that necessarily achieves results in the short term (Rowlands, 1997). In spite of the impediments there is also enormous strength in the process that has only begun. Looking at the current state of progress it gives an impression that by properly monitoring the progress and timely intervention to avert undesirable situation the effort of the community could be sustainable. With this optimistic note the researcher would also subscribe to the fact that it will be premature to draw conclusion on the certainty about the sustainability. The effort through CBFM is still at an experimental stage and it is still a long way to go to ensure the sustainability of the initiative.

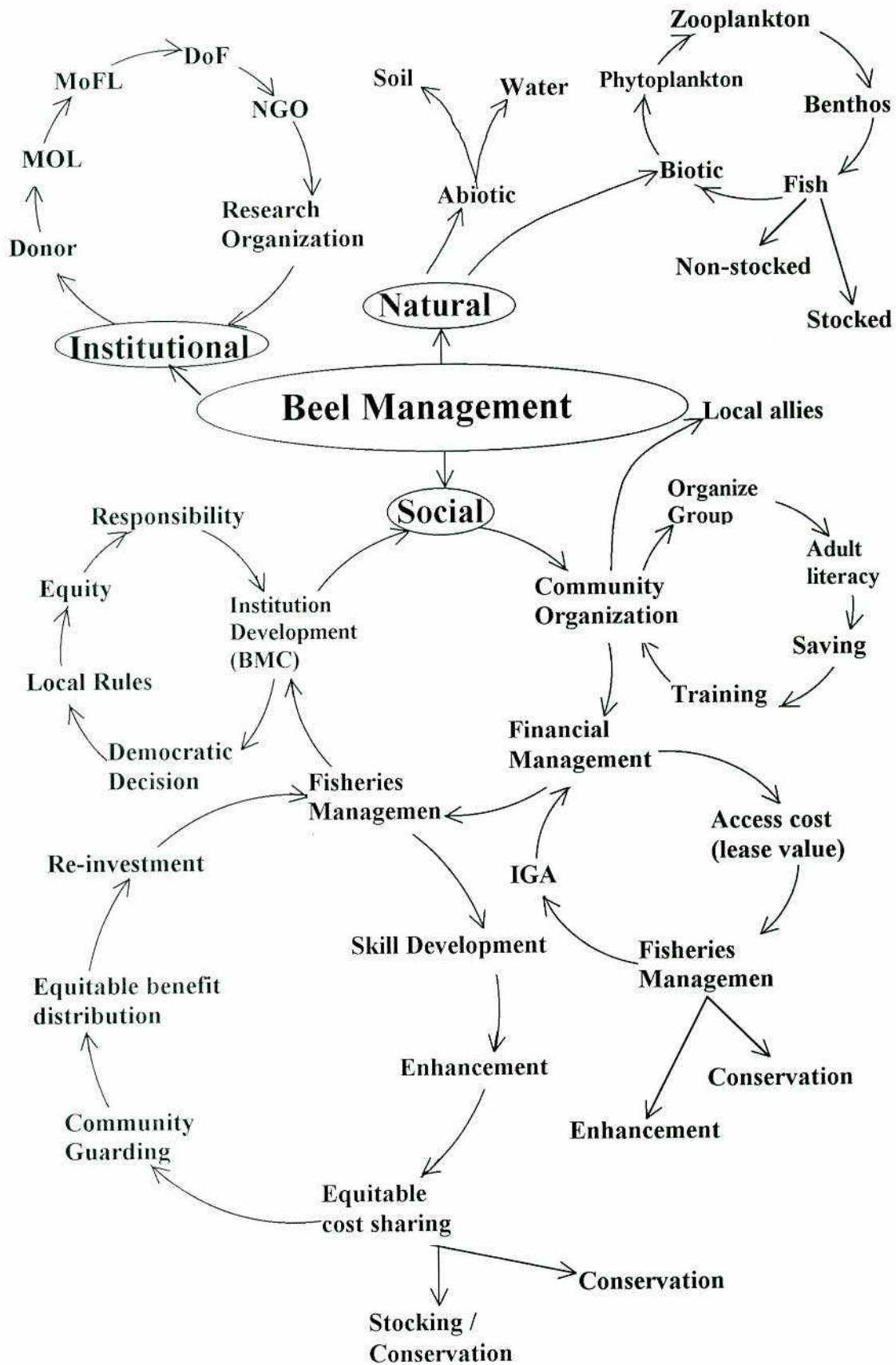


Figure 6.1: Sustainability of beel fisheries management

CHAPTER 7

CONCLUSION

The study has been conducted to investigate the impact of community based management in two beel fisheries, namely Hamil beel in Modhupur Thana of Tangail District and Rajdhala beel in Purbadhala Thana of Netrokona District. Duration of the study was for two years.

The study asserting that community based fisheries management can be applicable in public waterbodies as it has been demonstrated by both Hamil and Rajdhala beel communities. Through the finding of the study, the researcher was able to make a comparative analysis of both the beels in terms of the advantages and disadvantages in instilling community based management practice in the studied beels. These would be evident from the following aspects:

1. In Hamil beel introduction of community based approach was more fruitful and conducive compared to that of Rajdhala beel. This is because of the fact that:

- The Hamil beel community had little experience in some form of management practice even before CBFM. But Rajdhala beel was under the control of outsider and the community had little access in the management of the resource.
- Natural productivity of Hamil beel was better than that of Rajdhala beel.
- Catchment area of Hamil beel is larger than that of Rajdhala beel, which contributed to the production and subsequently, brought more benefit to the Hamil beel community.
- Lease fee was within the affordable limit of the Hamil beel community. In case of Rajdhala beel community it was beyond their capacity as the exorbitant lease fee was not compatible with the socio-economic condition of such newly organized community.

2. Bio-physico-chemical parameters of the beels were in favor of fish productivity.

3. Production results revealed that by installing fisheries management practices, production have improved significantly. At the same time it was also observed that indigenous fish contributed substantially to the total production, but increment of stocked fish reduced the productivity of non-stocked fish.

4. Short tenure of leasing period found one of the areas that jeopardize the total effort of the community in establishing community management. It also has a number of implications.

Because of short lease period, the community did not feel the sense of ownership over the resource, as they feel insecure about the continuity of the process. It was observed that due to this uncertainty, the community was skeptical about investment *i.e.*, either in the form of infrastructure development or inputs.

5. Establishment of Community Institution in the form of Beel Management Committee (BMC) was a commendable effort. It was observed that the BMCs have been able to shoulder responsibilities of different nature, which otherwise would not have been possible for any individuals to carry out. BMCs ultimately became the voice of the communities.

6. It has been noted that some essential prerequisites have been met to be able to put the community based management effort in the path of sustainability. The organizing part has been done successfully and there is no dilemma on the issue of community management. With the formation of the groups, the communities were able to identify the purpose of their involvement in the process. Different kinds of training helped them to excel their management and technical skills. Savings built up and IGPs were helpful for increasing their financial capacity. Rapport building through the forum of development allies was able to foster relationship between different actors. Installing these systems, give a good indication about the future prospect of the sustainability of the effort.

7. In both the beels it was observed that there is inconsistency between the government record and the actual available physical possession of the beel area but lease fee is determined on the basis of recorded documentation, which caused conflicts especially in Hamil beel.

8. Support of Government legislation has been the most crucial aspect of the initiative. The primary objective of CBFM was to establish community management in the beels. Because of this instrument, the support of related government agencies have helped the communities to make steady progress in pursuit of their effort.

Community Management of Beel Fisheries holds enormous possibility provided the associated conditionalities are met. The role of supportive agencies *i.e.*, government departments, NGOs, research organizations is imperative. Collective efforts of all agencies along with the community institutions have the better prospect in establishing sustainable management in beel fisheries in Bangladesh.

CHAPTER 8

RECOMMENDATIONS

The study has been extensive and it dealt with a wide range of issues relating to the application of Community Based Management in two beels, namely, Hamil beel and Rajdhala beel. The researcher has had the opportunity to look into the minor details of the process, thus able to place some recommendations, which are believed to be the intrinsic elements for the effective application of Community Based Management of public waterbodies.

The objective of the study was to assess the impacts of community management in two beel fisheries in Bangladesh. This study brings about some areas that might pave the way for drawing some tangible suggestions for the establishment of effective community based management in the beel fisheries resource in the country. The recommendations are summarized below:

1. It is a precondition to ensure the participation of the community for this type of resource management. The participation however, should be ensured at all levels beginning from planning to implementation.
2. It is imperative to look at the level of decision-making capacity of the community. This capacity will not enhance automatically, unless they are empowered to take decisions free from any external influence. It would also be important to note that there are certain elements, which would contribute to the process of empowerment of the community. Some of those elements are:
 - Organizing the community in small groups.
 - Resource allocation.
 - Financial activity *i.e.*, savings, credit and income generation schemes.
 - Literacy course.
 - Training in the fields of general awareness raising, skill development and organizational development.
3. The sustainability of the groups depends on the access to the resources. It is therefore essential to make sure that the community does have unhindered access to the resource and appropriate the resource.

4. It has been observed that the short tenural arrangement is an impediment in translating the objective of the intervention to reality. It is emphasized that the period of tenure be made for a period of 15-20 years, so that the community can:
 - have a sense of ownership over the resource and
 - embark upon initiatives for further development of the resource.
5. It has also been found that the existing lease value is exceedingly high and hardly match with the production of the beels (Rajdhala beel) as well as socio-economic condition of the fishers. The fixation of lease value is still based on the concept of revenue augmentation. It is therefore recommended that the lease value should be fixed on considering of the production of the resource and socio-economic condition of the resource users. This task (assessing lease value) should be entrusted to a technically competent authority. It is further recommended that should the resource be allocated to the community then the lease fee for the first year may come as a grant or as interest free loan. It is also important to see that the lease value of waterbodies has rationality especially in comparison with the lease value of agriculture lands.
6. It is recommended that fisheries production enhancement effort must observe some specific norms—specifically allowing growth and biological behavior (breeding). To be able to achieve this and at the same time refrain the community from fishing during this period, process must be devised to provide alternative livelihood arrangement. This can be done through implementation of various types of income generation activities. Therefore, provisions for Revolving Loan Fund shall have to be provisioned for such activities.
7. The study findings show that the BMCs have played a critical role in the process of installing community management practice. It is highly recommended that the main role of coordinating the activities of the community is guided by an Institution, which would function in a democratic way and would ensure that the work is carried out in an efficient, equitable and sustainable manner.
8. Since beel fisheries management would involve a section of the community of a particular profession the role of other resource users is also vital. The support of the wider section of the community would also be effective. It is therefore recommended that a forum involving all the users of the resource is built and an amiable condition exists. This will minimize the prospect of any conflict among the resource users.

9. The Government is implementing a number of projects being undertaken by various government ministries *i.e.*, MoFL, MoL, LGED, Water Resources, Social Welfare etc. all aimed at poverty reduction of the common lot. Objective of these projects would be better served if these efforts were integrated with CBFM (where applicable).
10. Every initiative is bound to have a time frame within which the major objective will have to be achieved. But there is also a need for follow-up, even if it is done in low profile. But this has to be agreed upon at the designing stage of the project.
11. The community would need technical backup and would also require learning new techniques, methods for the furtherance of their work. Research should be ensured for guiding the community with technical information for enhancing resource output.
12. If tangible benefit is to be derived from Beel Fisheries, then the following needs to be given due thought.
 - Natural productivity of the resource management is practiced through making fish pass, establishment of sanctuary, re-excavation the connection with rivers to enhance the fish production for which government support is essential.
 - The stocking program should be further fine tuned to make it more effective.
13. The study, having dealt with wide range of areas based on different activities, made it possible to draw number of recommendations on the management aspect of the initiative, that might have policy implications. It would hence be realistic to use the findings of this study as a basis for area specific research work in the future. Further research may be initiated in the following areas:
 - Impact of stocked fish on indigenous fish.
 - Appropriate stocking guidelines for beel fisheries.
 - Assessment on beel biodiversity.

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ANNEXURES

Annex-A
Tables

Table 5a: Status of beneficiaries group

Sl.	Beel	Status	Group's name	Formed	Members		Savings
					1996	2001	
1	H	F	Satata MPS	09.02.96	17	15	11,820
	R	F	Kalduar MPS	18.02.96	24	24	16,560
2	H	F	Pubali MPS	14.02.96	20	20	13,960
	R	F	HatdhalaSapla MPS	24.01.96	26	25	23,550
3	H	F	Ekata M P S	06.02.96	28	27	13,875
	R	F	Hatdhala Ganger MPS	22.09.96	27	21	16,170
4	H	F	Sonali MPS	07.02.96	27	24	14,982
	R	F	Purbadhala MPS	24.01.96	22	24	17,240
5	H	F	Rupali MPS	04.02.96	25	21	11,530
	R	W	Hatdhala Agragati MMS	20.02.98	15	18	7,920
6	H	F	Bhumihin MPS	12.02.96	30	29	14,113
	R	W	Purbadhala Sonali MMS	25.02.98	16	19	7,980
7	H	W	Jamuna MMS	19.02.96	17	15	14,185
	R	-	-	-	-	-	-
8	H	W	Maddha Bilashpur MMS	28.02.96	16	23	5,705
	R	-	-	-	-	-	-
	H		Total		180	174	100,170
	R		Total		130	131	89,420

H- Hamil beel; R- Rajdhala beel; F- Fisher group; W- Women group

Table 5b: Exchange visits program

Year	Place of visit	Group member	Project staff	Remarks
1997	Hamil beel	15	6	Rajdhala beel groups visited Hamil beel
1997	Rajdhala beel	18	6	Exchange visit by Hamil beel groups
1998	Ashurar beel	21	5	Groups of both the beels visited Ashurar beel.
1998	OLP-II	12	5	Visited OLP-II project area to get on hand experience of community management.
1999	Banchte Sekha	8	6	To experience the role of women in the management of BMC.
2000	OLP-II	10	5	Follow-up visit to OLP-II
2000	Caritas Apex , Kalmakanda	16	6	Familiarize with the concept of peoples organization.

Table 5c: Types of Income Generation Projects

Type of IGPs	Hamil Beel		Rajdhala Beel	
	No. of Project/ Beneficiaries	Taka	No. of Project/ Beneficiaries	Taka.
Group loans				
Fingerling Purchase	3/414	145,361	1/93	165,000
Lease money	1/38	15,000	0	0
Boat Purchase	0	0	1/93	40,000
Pen construction	1/138	4,600	0	0
Revolving Fund				
Net Purchase	-	-	51	98,000
Fish drying	-	-	4	7,000
Fish trading	7	16,000	1	1,500
Small trading	20	40,000	3	4,500
Poultry rearing	-	-	3	4,500
Rice husking	11	23,000	2	3,000
Rikshaw/cart purchase	15	32,000	2	3,000
Carpentry tools	3	6,000	-	-
Bamboo craft	11	14,000	5	10,000
Kitchen gardening	15	55,000	14	52,000
Poultry & livestock	10	58,000	17	66,000
Total amount disbursed		408,961		454,500

Table 5d: Fish diversity in the studied beels

Sl.	Family	Scientific name	English name	Local name	Abundance					
					1972		1997		2000	
					H	R	H	R	H	R
1	Channidae	<i>Channa marulius</i>	Giant snake head	Gazar	C	VC	F	C	VF	F
2		<i>Channa punctatus</i>	Spotted snakehead	Taki	C	C	C	C	C	C
3		<i>Channa orientalis</i>	Asiatic snakehead	Telotaki	C	-	C	-	C	0
4		<i>Channa striatus</i>	Banded snake head	Shol	C	C	F	C	C	C
5	Cyprinidae	<i>Puntius sarana</i>	Olive barb	Sarpunti	C	C	VF	VR	NF	NF
6		<i>Puntius sophore</i>	Spotfin	Jatpunti	C	C	C	C	VC	VC
7		<i>Puntius conchoniis</i>	Rosy barb	Kanchan	C	C	C	C	VC	VC
8		<i>Puntius ticto</i>	Ticto barb	Titpunti	VC	VC	C	C	VC	VC
9		<i>Rasbora rasbora</i>	Gangetic scissortail rasbora	Darkina/ Dankina	C	C	F	F	C	F
10		<i>Amblypharyngodon mola</i>	Mola carplet	Mola	VC	VC	F	F	C	VF
11		<i>Osteobrama cotio</i>	Cotio	Dhela	C	-	VF	-	NF	-
12		<i>Salmostoma bacaila</i>	Large razorbelly minnow	Katari/ Narkeli chela	C	C	VF	F	F	VF
13	Belonidae	<i>Xenentodon cancila</i>	Freshwater garfish	Kakila	C	C	F	F	C	F
14	Clupeidae	<i>Gudusia chapra</i>	Indian river shad	Chapila	VC	VC	F	F	VC	VC
					H	R	H	R	H	R

Sl.	Family	Scientific name	English name	Local name		Abundance				
						1972	1997		2000	
		<i>Corica soborna</i>	Ganga river sprat	Kachki	VC	-	F	-	C	-
15	Bagridae	<i>Aorichthys aor</i>	Longwhiskered catfish	Aor	F	F	VF	VF	NF	NF
16		<i>Aorichthys seenghala</i>	Giant river catfish	Guizza aor	C	C	F	F	C	C
17		<i>Mystus tengra</i>	Tengra mystus	Bajari tengra	– VC	VC	C	F	VC	VC
18		<i>Mystus cavasius</i>	Gangetic mystus	Golsha	C	VC	VF	VF	F	F
19		<i>Mystus bleekeri</i>	Day’s mystus	Golsha-tengra	C	C	VF	VF	VF	VF
20	Siluridae	<i>Ompok pabda</i>	Pabdah catfish	Pabda	C	C	F	VF	C	F
21		<i>Wallgo attu</i>	Freshwater shark	Boal	C	C	F	VF	VF	F
22	Schilbeidae	<i>Pseudeutropius atherinoides</i>	Indian potasi	Batashi	C	C	VF	VF	NF	F
23	Clariidae	<i>Clarias batrachus</i>	Magur	Magur	C	C	F	C	C	C
24	Heteropneustidae	<i>Heteropneustes fossilis</i>	Stinging catfish	Singi	C	C	F	C	C	C
25	Tetradontidae	<i>Tetradon cutcutia</i>	Ocellated puffer fish	Tepa/potka	C	C	VF	F	NF	F
26	Mastacembelidae	<i>Macrognatrhus aral</i>	One-stripe spinyeel	Tara baim	C	C	F	C	C	C
27		<i>Macrognatrhus pancalus</i>	Striped spinyeel	Guchi baim	C	C	C	C	C	C
					H	R	H	R	H	R

Sl.	Family	Scientific name	English name	Local name	Abundance					
					1972		1997		2000	
28	Anabantidae	<i>Anabas testudineus</i>	Climbing perch	Koi	C	C	F	VF	C	C
29	Belontiidae	<i>Colisa fasciatus</i>	Stripled gourami	Khailsha	C	C	C	F	VC	C
30		<i>Colisa lalia</i>	Dwarf gourami	Ranga khalisha	C	C	F	C	C	VC
31	Nandidae	<i>Nandus nandus</i>	Mottled nandus	Meni	C	C	VF	VF	NF	VC
32	Leiognathida e	<i>Leiognathus equulus</i>	Common ponyfish	Chanda	C	C	C	C	C	VC
33	Gobiidae	<i>Glossogobius giuris</i>	Tank goby	Bailla	C	C	F	F	VC	VC
34	Mugilidae	<i>Rhinomugil corsula</i>	Corsula mullet	Khalla	C	-	VF	-	NF	-
35	Notopteridae	<i>Notopterus chitala</i>	Humped leatherback	Chital	C	-	VF	-	NF	-
36		<i>Notopterus notopterus</i>	Grey Featherback	Pholi	C	-	VF	-	VF	-
37	Cyprinidae	<i>Labeo rohita</i>	Rohu	Rui						
38		<i>Labeo calbasu</i>	Kalbasu	Kalibaus						
39		<i>Labeo gonio</i>	Kuria labeo	Ghoina						
40		<i>Catla catla</i>	Catla	Katal						
41		<i>Cirrhinus mrigala</i>	Mrigal	Mirka						
42		<i>Ctenopharyngodon idella</i>	Grass carp	Grass carp						
43		<i>Hypophthalmichthys molitrix</i>	Silver carp	Silver carp						
44		<i>Cyprinus carpio</i> var. <i>communis</i>	Scale carp	Common carp						

Sl.	Family	Scientific name	English name	Local name	Abundance		
					1972	1997	2000
45		<i>Cyprinus carpio</i> var. <i>specularis</i>	Mirror carp	Mirror carp			
46		<i>Barbodes gonionotus</i>	Silver barb	Thai sarpunti			

H-Hammil beel; R-Rajdhala beel; 1-36 Naturally dwelled fish; 37-46 Stocked fish; C-Common, VC-Very Common, F-Few, VF-Very Few, N-Nil, NF- Not Found

Table 5e: List of aquatic plants in the studied beels

Sl.	Scientific name	English name	Local name	Category	H	R
1	<i>Vallisneria</i> sp.	Eelgrass	Patayr	Submerged	A	P
2	<i>Azolla</i> spp.	Waternvalvet	Kutipana	Free floating	P	P
3	<i>Lemna</i> sp.	Duckweed	Khudipana	Free floating	P	P
4	<i>Eichornia crassipes</i>	Water hyacinths	Kachuripana	Free floating	P	P
5	<i>Nymphaea</i> sp.	Red waterlily	Lalshapla	Leafy floating	P	P
6	<i>Ipomoea aquatica</i>	-	Kalmisak	Emergent	P	P
7	<i>I. fistulosa</i>	-	Dolkalmi	Emergent	P	P
8	<i>Ludwigia adscendens</i>	-	Keshordam	Emergent	P	P
9	<i>Colocasia esculenta</i>	-	Kachu	Emergent	P	P
10	<i>Leersia hexandra</i>	-	Arail	Emergent	A	P
11	<i>Potamogeton</i> sp.	Pond weed	-	Submerged	P	P

H- Hamil beel; R- Rajdhala beel; P- Present; A- Absent

Table 5f. Total number of fingerlings stocked and total yield performance of Hamil beel

Species	Fingerling stocked (Nos.)			Total	Av	Production									Total	Av
						Yield (kg)			Total	Av	Production(Nos.)					
	1998	1999	2000			1998	1999	2000			1998	1999	2000			
<i>H. molitrix</i>	8,555	11,253	18,708	38,516	12,839	949	724	1,487	3,160	1,053	1,240	1,296	2,100	4,636	1545	
<i>C. idella</i>	2,050	3,319	0	5,369	1,790	0	235	2	237	79	0	340	2	342	114	
<i>C. carpio var. communis</i>	5,187	2,266	7,000	14,453	4,818	2,775	1,099	654	4,528	1,509	2,595	1,180	787	4,562	1521	
<i>C. catla</i>	25,761	14,040	27,810	67,611	22,537	2,340	1,978	2,290	6,608	2,203	4,500	3,094	6,928	14,522	4841	
<i>L. rohita</i>	34,517	5,050	11,030	50,597	16,866	1,126	718	1,189	3,033	1,011	3,698	1,948	5,698	11,344	3781	
<i>C. mrigala</i>	20,240	11,473	24,850	56,563	18,854	957	2,432	2,194	5,583	1,861	2,644	6,750	7,554	16,948	5649	
<i>Other</i>	1,800	0	0	1,800	600	703	29	0	732	244	426	18	0	444	148	
Total stocked fish	98,110	47,401	89,398	234,909	78,303	8,850	7,215	7,816	23,881	7,960	15,103	14,626	23,069	52,798	17599	
<i>G. chapra</i>	NA	NA	NA	NA	NA	611	1,858	1,443	3,912	1,304	NM	NM	NM	NM	NM	
<i>Puntius spp.</i>	NA	NA	NA	NA	NA	500	622	594	1,716	572	NM	NM	NM	NM	NM	
<i>Chanda spp.</i>	NA	NA	NA	NA	NA	99	181	307	587	196	NM	NM	NM	NM	NM	
<i>A. mola</i>	NA	NA	NA	NA	NA	1,005	1,169	444	2,618	873	NM	NM	NM	NM	NM	
<i>Chela sp.</i>	NA	NA	NA	NA	NA	394	213	0	607	202	NM	NM	NM	NM	NM	
<i>W. attu</i>	NA	NA	NA	NA	NA	0	148	20	168	56	NM	NM	NM	NM	NM	
<i>Aorichthys spp.</i>	NA	NA	NA	NA	NA	1,239	761	245	2,245	748	NM	NM	NM	NM	NM	
<i>Other</i>	NA	NA	NA	NA	NA	0	358	97	455	152	NM	NM	NM	NM	NM	
Total non-stocked fish	NA	NA	NA	NA	NA	3,848	5,310	3,150	12,308	4,103	NM	NM	NM	NM	NM	
Total (stocked +non-stocked)	NA	NA	NA	NA	NA	12,698	12,525	10,966	36,189	12,063	NM	NM	NM	NM	NM	

NA=Not applicable; NM=Not measured

Table 5g. Fingerling stocked (ind/ha) and yield (kg/ha) of Hamil beel

Species	Fingerling stocked(Ind/ha)			Total	Av	Production									Total	Av
						Yield (kg/ha)					Production(Nos./ha)					
	1998	1999	2000			1998	1999	2000	Total	Av	198	1999	2000			
<i>H. molitrix</i>	535	703	1,169	2,407	802	59.3	45.3	92.9	197.5	65.8	78	81	131	290	97	
<i>C. idella</i>	128	207	0	336	112	0.0	14.7	0.1	14.8	4.9	0	21	0	21	7	
<i>C. carpio var.communis</i>	324	142	438	903	301	173.4	68.7	40.9	283.0	94.3	162	74	49	285	95	
<i>C. catla</i>	1,610	878	1,738	4,226	1,409	146.3	123.6	143.1	413.0	137.7	281	193	433	908	303	
<i>L. rohita</i>	2,157	316	689	3,162	1,054	70.4	44.9	74.3	189.6	63.2	231	122	356	709	236	
<i>C. mrigala</i>	1,265	717	1,553	3,535	1,178	59.8	152.0	137.1	348.9	116.3	165	422	472	1,059	353	
<i>Other</i>	113	0	0	113	38	43.9	1.8	0.0	45.8	15.3	27	1	0	28	9	
Total stocked fish	6,132	2,963	5,587	14,682	4,894	553.1	450.9	488.5	1492.6	497.5	944	914	1,442	3,300	1100	
<i>G.chapra</i>	NA	NA	NA	NA	NA	38.2	116.1	90.2	244.5	81.5	NM	NM	NM	NM	NM	
<i>Puntius spp.</i>	NA	NA	NA	NA	NA	31.3	38.9	37.1	107.3	35.8	NM	NM	NM	NM	NM	
<i>Chanda spp.</i>	NA	NA	NA	NA	NA	6.2	11.3	19.2	36.7	12.2	NM	NM	NM	NM	NM	
<i>A. mola</i>	NA	NA	NA	NA	NA	62.8	73.1	27.8	163.6	54.5	NM	NM	NM	NM	NM	
<i>Chela sp.</i>	NA	NA	NA	NA	NA	24.6	13.3	0.0	37.9	12.6	NM	NM	NM	NM	NM	
<i>W. attu</i>	NA	NA	NA	NA	NA	0.0	9.3	1.3	10.5	3.5	NM	NM	NM	NM	NM	
<i>Aorichthys spp.</i>	NA	NA	NA	NA	NA	77.4	47.6	15.3	140.3	46.8	NM	NM	NM	NM	NM	
<i>Other</i>	NA	NA	NA	NA	NA	0.0	22.4	6.1	28.4	9.5	NM	NM	NM	NM	NM	
Total non-stocked Fish	NA	NA	NA	NA	NA	240.5	331.9	196.9	769.3	256.4	NM	NM	NM	NM	NM	
Tota l(stocked+non-stocked	NA	NA	NA	NA	NA	793.6	782.8	685.4	2261.8	753.9	NM	NM	NM	NM	NM	

NA=Not applicable ;NM=Not measured

Annex-B

Figures

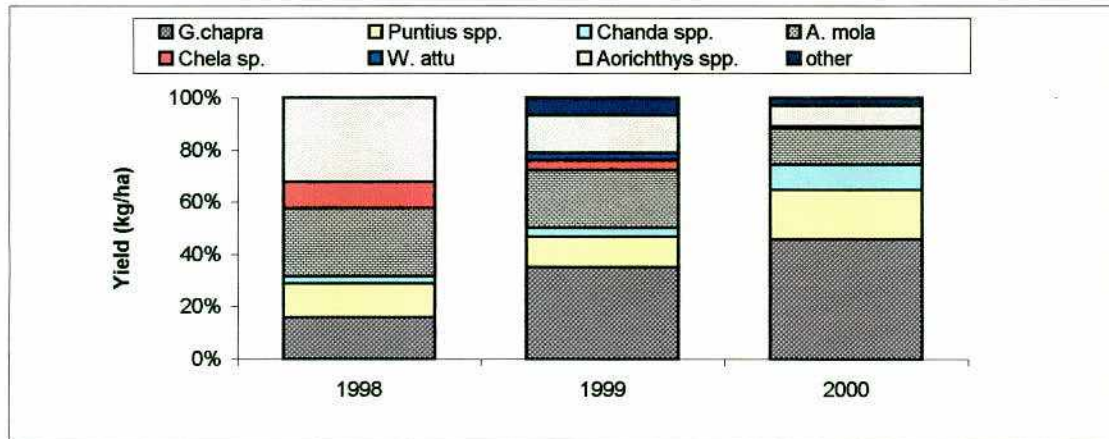


Figure 5a. Yield of non-stocked indigenous fish in Hamil beel

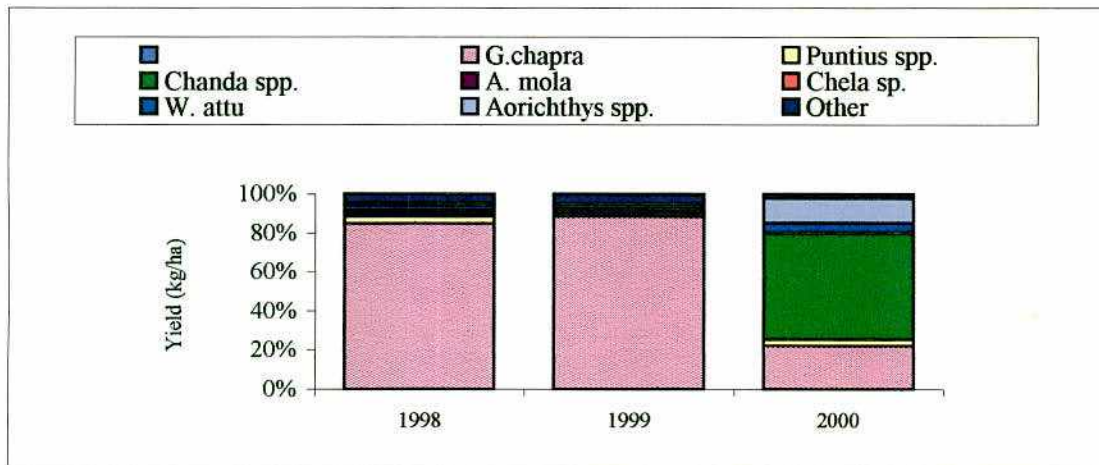


Figure 5b: Yield of non-stocked fish in Rajdhala beel

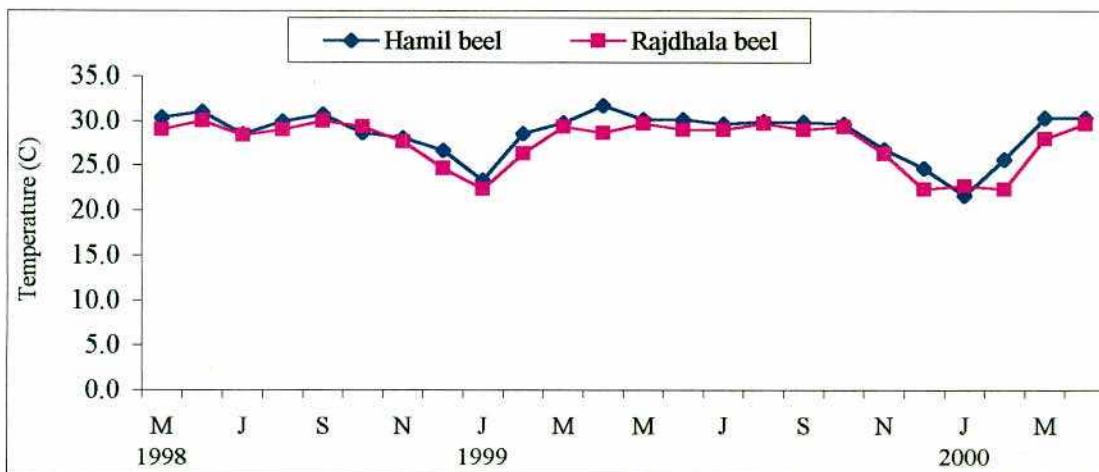


Figure 5c: Monthly water temperature in the studied beels

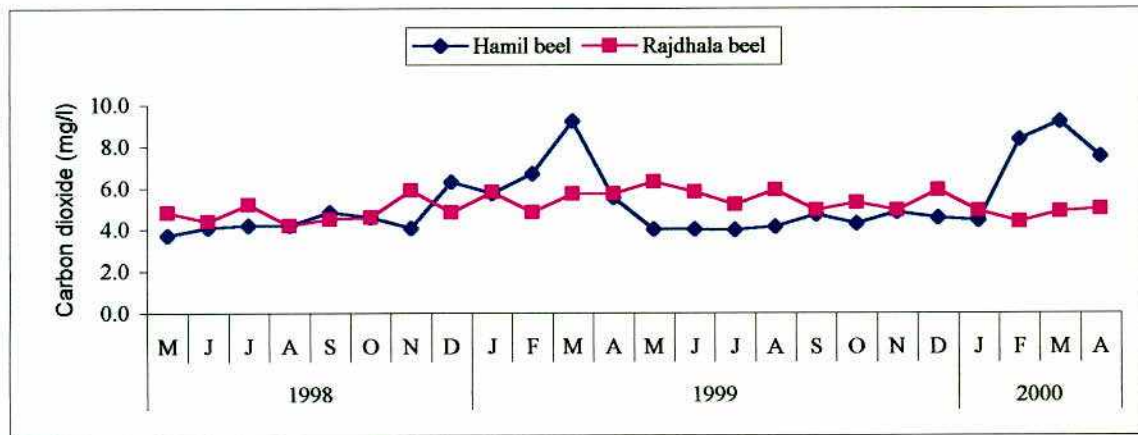


Figure 5d: Monthly carbon dioxide in the studied beels

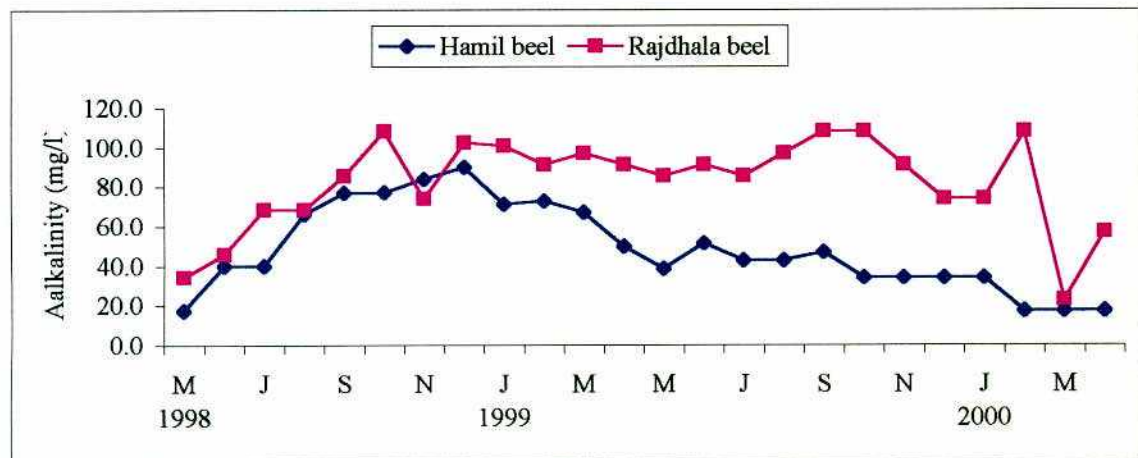


Figure 5e: Monthly alkalinity in the studied beels

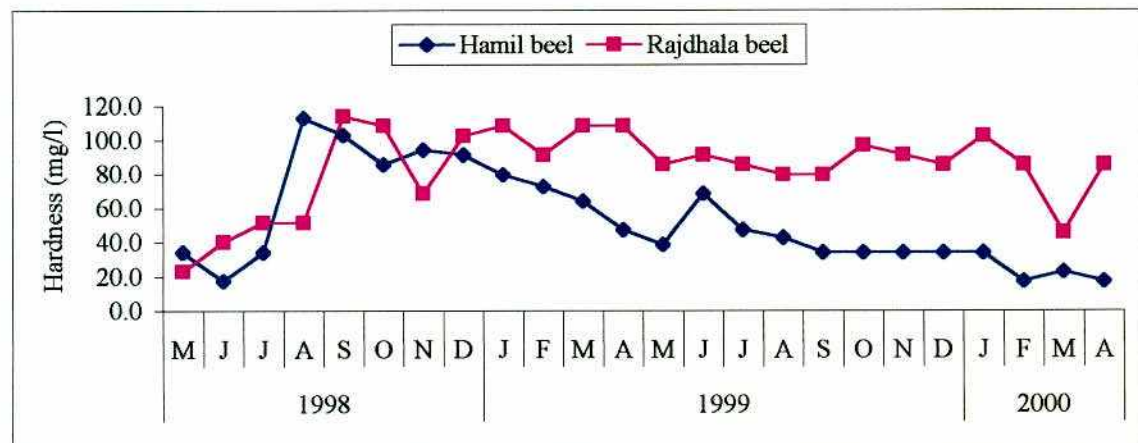


Figure 5f: Monthly hardness in the studied beels

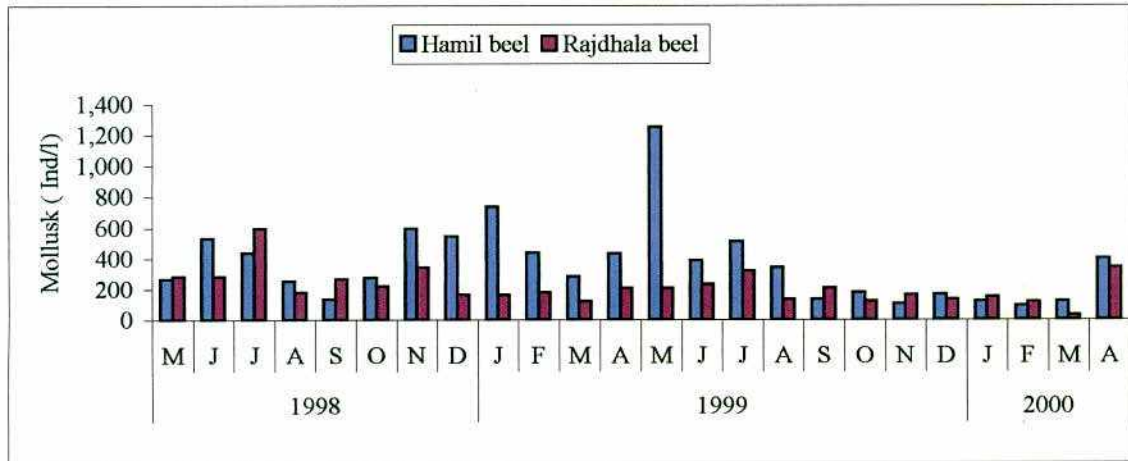


Figure 5g: Monthly abundance of Mollusk in the studied beels

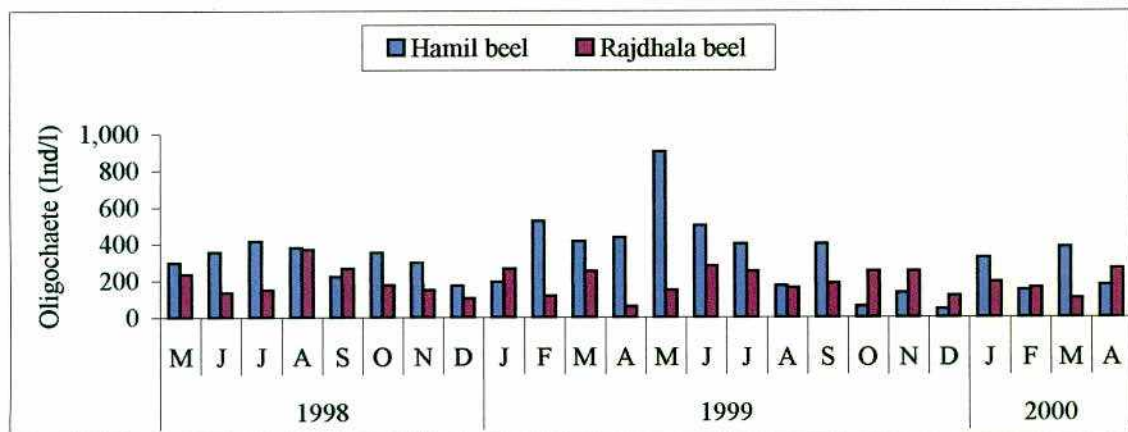


Figure 5h: Monthly abundance of Oligochaete in the studied beels

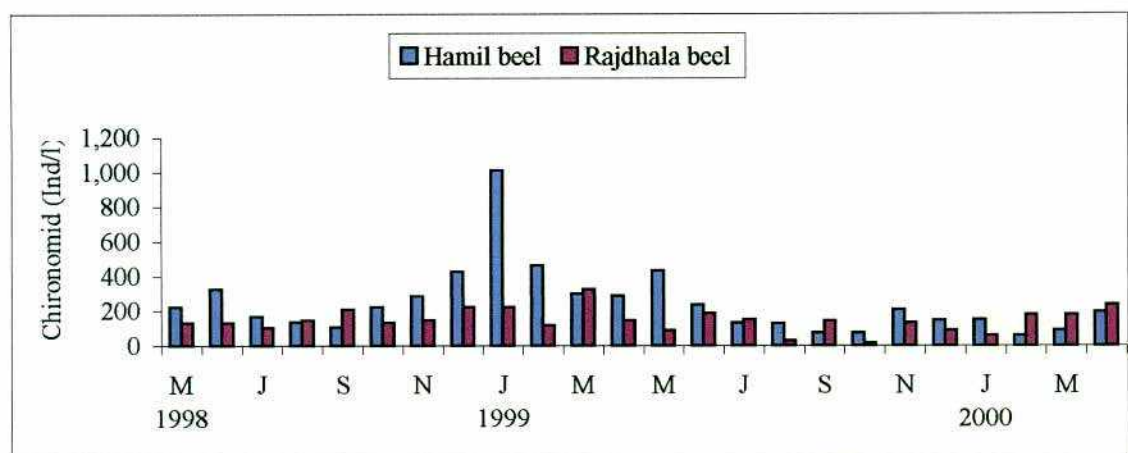


Figure 5i: Monthly abundance of Chironomid in the studied beels