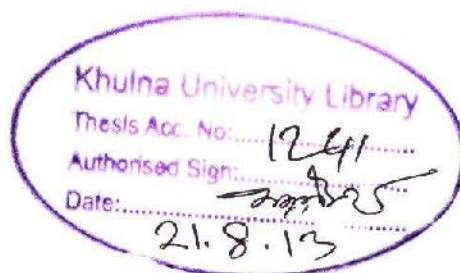


**HABITAT, FISH BIODIVERSITY DEGRADATION AND
PREVAILING MANAGEMENT SYSTEM OF BARNI BAOR
AND MADHUMATI BAOR IN GOPALGONJ DISTRICT**



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December, 2011

**HABITAT, FISH BIODIVERSITY DEGRADATION AND
PREVAILING MANAGEMENT SYSTEM OF BARNI
BAOR AND MADHUMATI BAOR IN GOPALGONJ
DISTRICT**

A Thesis

By

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Declaration

HABITAT, FISH BIODIVERSITY DEGRADATION AND PREVAILING MANAGEMENT SYSTEM OF BARNI BAOR AND MADHUMATI BAOR IN GOPALGONJ DISTRICT

The results presented in the thesis with the above mentioned title are entirely of the candidate's own investigations and no part of the results has been accepted for any degree nor is it being concurrently submitted for any degree.

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DEDICATED
TO
MY RESPECTABLE PARENTS

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At first all my admiration goes to the supreme creator and ruler of the universe, God For his great mercy to create and alive me.

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Abstract

The study was conducted at two baors namely, Barni baor in Tungipara upazila and Madhumati baor in Kashiani upazila under Gopalganj district during January to November, 2011. This study provides an overview of the current resources and fisheries status of the baors, and of existing fisheries management strategies, focusing on fish biodiversity conservation. These are two large and important watersheds in the south-west region of Bangladesh and serve about 10000 people, predominantly through fisheries and agricultural activities. The area of Barni and Madhumati baor is about 121.45 ha. and 191 ha. respectively. The water quality parameters of these water bodies represent habitat for fresh water inland fish species. It was also observed that the watersheds are being considerably degraded over time. A fish catch survey was carried out in the main fishing seasons (January to March and September to November) during a year. Barni baor contains around 38 species of indigenous fish and among them, 33 species are available, 5 are in endangered condition and 3 (*Clupisoma garua*, *Gudusia chapra*, *Rita rita*) are found to be locally extinct. In case of Madhumati baor about 47 species were found of which 41 species are available, 4 species were found to be threatened and 2 species are possibly extinct from the water body. The stoked fish in these water bodies are *Labeo rohita*, *Catla catla*, *Cyprinus carpio*, *Puntius sarana* etc. A few years ago the production rate was higher than that of present situation and this trend is going on. At present there is no effective fisheries management in both baors. But a few years ago, both of the baors are conducted by leasing system and govt. would take revenue from this resources.



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List of Abbreviations

BBS	Bangladesh Bureau of Statistics
BRAC	Bangladesh Rural Advancement Committee
DoF	Department of Fisheries.
FFG	Fish Farmers Group
IFAD	International Fund for Agricultural Development
IUCN	International Union for the Conservation Nature
LFT	Lake Fisheries Team
LMG	Lake Management Group
MOFL	Ministry of Fisheries and Livestock
NGO	Non Government Organization
OLP	Oxbow Lake Project
PD	Project Director



Chapter 1

Introduction

1.1. Background of the study

Baor is a dead arm of a river; it is also called oxbow lake. It appears as a saucer shaped depression (Hossain *et al*, 1997). The term *baor* is synonymous to beel, familiar in the southwestern part of Bangladesh. The notable baors of the country are Sagarkhali, Jaleshwar, Khedapara, Barni, Rampur, Madhumati, Pathanpara, Kathgara, Jogini Bhagini, Ichamati, Joydia, Marjat, Harina and Arial. They range in size from half a square kilometre to 13 sq km. Baors are more stagnant than beels and generally have water throughout the year. The most common view regarding its origin is that when a river changes its course some of its sections at the supply source get silted-up, cuts off the arms, and develops an oxbow lake called baor. Baors receive water only when the parent river is in high flood. Usually, during the wet season a baor receives local rainwater. At times, the accumulated water may spill over from the adjacent floodplain and may cause local flooding. Baors are considered to be very important wetlands of Bangladesh and support a wide range of aquatic lives (flora and fauna). Relatively higher peripheral land along the baors is used for cultivating paddy and for grazing livestock.

Fisheries sector is playing a vital role regarding employment generation, animal protein supply, and foreign currency earning and poverty alleviation. Fisheries sector is contributing 2.70% of total export earning and 3.74% to the GDP in 2009-2010 fiscal years (Matsya Paksha, 2010). About 12 million people are directly or indirectly involved in this sector. Labor employment in this sector has been increasing approximately by 3.5% annually. Fish production in ponds, lakes, burrow pits, floodplains, oxbow lakes and semi-closed water bodies are increasing day by day.

Bangladesh is a uniquely rich in water bodies in the form of ponds, rivers, canals, ditches and floodplain (natural depression), baors (oxbow lake) rivers estuaries and other covering an

area of 4.58 million hectares, which has been considered as the major source fisheries production (Rahman, 2005).

The fisheries sector in Bangladesh is one of the most potential and also relatively neglected sectors in the country. In recent years there has been a relatively unheralded revolution in the aquaculture sector all over the country with government, NGO's and most importantly private sector leading the way in promoting aquaculture in pond and other closed water bodies (Huq, 2000).

The fisheries sector represents an important source of rural income, employment, nutrition and foreign exchange in Bangladesh. Over 1.2 million full time and 12 million part time people are estimated to be engaged in fisheries related activities. Since time immemorial the fisheries community is carrying out their unthinkable in human suffering for survival, enjoying the lowest level of social status. In this connection, baor fishery has a great contribution among them because it consists of 5,488 ha area of the country (Hossain, 1997). Fish and fishery play a vital role in the national economy.

Fish in Bangladesh come mainly from two sources – inland and marine. Fish production of the country for the years 2005–06 is estimated at 2.32 million metric tons, 79% of which comes from inland waters (constituting 41% from inland open water bodies and 38% from inland closed water systems) and the rest from the marine. Covering an estimated total of 4.3 million hectares, the inland fishery with nearly 277 species provides significant livelihood opportunities for the people of Bangladesh waters (DoF, 2006; Ahmed, 2005). The fisheries sector accounted for about 3% of the country's GDP, 28% of the value added in agricultural production, and 6% of total export earnings in 2003/04. Fish provide about 63% of the total animal protein intake in the country (Bangladesh Economic Review, 2005). The inland fisheries of Bangladesh operate under complex biological and institutional conditions. Several government ministries and departments directly or indirectly provide inputs to fisheries management in Bangladesh, including the Ministry of Land (MOL), the Ministry of Fisheries and Livestock (MoFL), the Ministry of Agriculture, the Ministry of Communication, the Department of Fisheries (DoF), the Bangladesh Forest Department (BFD), and the Bangladesh Water Development Board (BWDB). Owing to a diversity of interests and a lack of coordination, a considerable amount of rivalry and conflicts exist

among the different ministries. Two ministries play major roles in managing the country's fisheries – the Ministry of Land and the Ministry of Fisheries and Livestock. The Ministry of Land owns all inland fisheries resources except the privately owned water bodies such as ponds, and is responsible for the administration of leases and the regulation of access to these fisheries resources. The Ministry of Fisheries and Livestock is responsible for the conservation, protection and management of the fish stocks. The Department of Fisheries under the MoFL is the main government organization mandated to develop this sector in Bangladesh (Farooque, 1997).

Baors were the properties of *Zomindars* (landlords) during the British colonial days (1757-1947) and became government property after the abolition of the *Zomindary* system through a land settlement Act in 1951 (Dewan, 1994). They were leased to private individuals or cooperatives through open auctions. Individual leaseholders with the use of short-term lease contract (for three years) were rarely enthusiastic to invest in stocking or fish resource up-keeping in such a vast and extensive water bodies with huge overseeing/enforcement costs in an open access system. In most cases lease of these water-bodies were taken as a prestige possession and demonstration in the socio-economic setting of the countryside.

1.2. Problem statement

Oxbow lakes and baors are one of the most productive and resourceful which provide food, non-food aquatic resource and maintain the ecological balance for the local residents as well as for the nation. The study was conducted at Borni and Madhumati baor in Gopalganj district. These water bodies support a lot to the economics of our country and provide opportunity for earning livelihoods of local people. But now-a-days the habitat for fisheries resources is changing due to climate change and philanthropic activities which is threat to our biodiversity. Already we have lost some flora and fauna from these closed water bodies (Haque, 1997). Therefore this is high time to take necessary steps to protect the habitat as well as biodiversity of our water bodies and establish the ecological balance.

1.3. Objectives of the study

The study was conducted to estimate the condition of the habitat the baors, its biodiversity (present and past situation), prevailing measures how much it is effective for sustainable fishery management. It was accomplished through personal interview and observation by a structured questionnaire, field work and laboratory work. The findings of the present study may contribute largely in the formulation of appropriate management measures for the baor fishery and policy maker of Bangladesh. Therefore, this study has been set out to assess the following objectives.

- To assess the biodiversity of the above two baors in Gopalganj.
- To find out the habitat condition for fish in these water bodies.
- To identify the cause of biodiversity and habitat degradation in the Baors and draw up the necessary steps for future management.

Chapter-2

Review of Literature

2.0. Review of Literature

Prior to conduct an experiment, it is essential to know the information about the previous research works. However, information on the habitat of baor, its biodiversity and prevailing management practice were collected which are compiled herewith as the review of literature.

Hossain *et al.* (1997) recorded 43 fish species from two floodplains in the south-western region of Bangladesh in 1992-1995. Rahman (1989) reported 260 fresh water species from floodplains, lakes and rivers of Bangladesh. The indigenous fish species, reported oxbow lakes under culture based fisheries management, appear not different from a control lake (Haque *et al.*, 1997).

Ostrom (1990) in his study mentioned Oxbow lakes as common resources abundant with the fish and the water forming part of the common resource. Unmanaged common resources become “open access” and tend to be over-used by the people living near such resources. Like Ostrom (1990) and Pomery (1994) concluded that common property regimes are forms of management grounded in a set of accepted rights rulers by a group of resource users for the sustainable and interdependent use of collective goods.

Apu (*et al.*, 1997) found in his study that the members of the Bahadurpur fishers group not just catch fish but they actually manage the fisheries resource as a common property regime. In the day-to-day implementation of the common property regime in oxbow lakes, the Fishing Rules are upheld to ensure participation in fishing maintain equity and enforce LMG democracy by rotation of leadership.

Ruddle (1994) found that Governments of many countries in Asia and the Pacific often underestimate the role and capacities of local communities in the management of fisheries, while at the same time local communities also cannot successfully implement fisheries management by themselves alone.

Presently, 20 lakes are under intensive culture-based fisheries management by the fishers groups and stocked with carp fingerlings of six different species (Middendorp *et al.*, 1996). A detailed analysis of the financial performance of ten fishers groups in their fifth year of operation is presented (Middendorp *et al.*, 1997). Middendorp and Balarin (1997) reported that culture based fisheries is considered as a kind of farming, as it involves ownership of the fish as well as management control.

Fishing is considered as a low-class profession and fishermen are traditionally poor. They lived from hand to mouth (Hannan, 1994). These fishermen are socially, economically and educationally disadvantaged communities and lack their own financial resources (Rahman, 1994 b). Fishermen and their families in the South and South East Asia often are considered to be among the poorest of the poor (Bailey, 1994).

In Bangladesh, most of the fishermen are illiterate and few have primary level of education (Rahman, 1994a). Coastal fishermen of Bangladesh have a low level of education (Bailey and Doulman, 1994).

Ahmed (1996) found that the full time fishermen in Tangail district area were 84%; 24% had subsidiary occupation, 81% were found fishing throughout the year and 92% were member of some associations, clubs and co-operatives.

Mahabubullah (1986) studied the polder fishing community of Bangladesh. He reported that among the polder fishing community 64% had no boat and 61 % had no gear. While, 98% reported, fishing as their main source of income and 71% earned 400 taka per month or above. A similar study was conducted by DoF (1993) on fishermen community of the Chanda beel and revealed that there were 22% professional and 74% non-professional fishermen. 85% carried out fisheries activities individually, 5% were members of cooperatives, 34% aware of NGO programs. Average household income was 15000 taka per year.

DoF (1990) further conducted a survey on the socioeconomic conditions of the fishermen in eleven upzillas of the district of Patuakhali and Barguna under Fisheries Extension Development Project and reported that rate of literacy among fishing communities was far less than other areas. Their economic condition was so bad that they often could not afford educational expenses for their children. This study reported that about 70-80% fishermen were laborers (work in other gear and boats); about 70% of fishermen had an average daily income of taka 20-25, and the rest 30% taka 25-40.

Biodiversity in Bangladesh contributes significantly to the country's economy. The people of Bangladesh depend on biodiversity for their day-to-day sustenance as well as overall livelihood security. For example, over 60 million people are dependent on aquatic resources every day. One million people are full-time fisher folk and another 11 million have taken to part-time fishing in the country. Fifty to sixty-five per cent of the country's protein requirement is met by the consumption of fish. The fisheries sector contributes about 3.3% of the GDP of Bangladesh, earning more than 11% or more of the total export revenue, and employs 5% of the country's total work force (Parveen and Faisal 2001). The agriculture sector provides 63.5% of the country's employment, contributing a considerable 24% to the GDP. Of the sector's contribution to the GDP, approximately 7.1% is covered by the forestry. The various forestry-related projects in the country together generate 90 million person-days of job opportunities every year. The Sundarbans provides livelihood and employment to an estimated 112,000 people (Khan 2001).

About 260 species of freshwater fishes are found in the inland water bodies of Bangladesh. Inland fisheries alone cover an area of 4.3 million hectares of which 94% comprise open water capture fisheries, and only 6% close water system. The haors, beels and baors offer tremendous scope and potential to augment fish production by adoption of culture-based fishery enhancement technique. (Chakraborty *et al.* 2005).

Chakraborty *et al.* (1995) described the fishing methods used in inland waters of Bangladesh along with the structural design of various types of fishing gears. These gears have been classified into nine major categories according to their mode of operation and the capabilities



of these gears have been reviewed in terms of harvesting fish from inland water bodies of Bangladesh.

The fishing techniques that are currently in use amongst the fishermen of Bangladesh have been broadly categorized into netting, angling, trapping, spearing, dewatering and hand picking (Dewan and Mazid, 1994). They also reported that at present a total of 91 gears under broad categories have been found to be used amongst the fishermen in different types of water bodies of the county. Among the gears, they found 28 gill nets, 8 drag and bag nets, 8 lift 5 clasp, cast and push nets, 6 hooks and lines, 5 traps and 5 spears /harpoons. They also recorded 7 new gears during their study which are phoot jal, paia jal, patpati jal, dool-chot jal, sruti jal, bhuri jal, gorja jal. Among the newly recorded jals, 3 are being used in beels and other 4 jals in rivers. They also indicated that phooti jal, patpati jal, paia jal as gill net dool-chot (seine net), suti jal (bag net), bhurijal (clasp net) and gurja jal (dragged net).

According to BCAS (1991) approximately 30 different types of fishing gears have been identified to be used in Haldi beel. The major species of fish caught in this beel are koi, shing magur, raikh, boal, shoal, air, punti, baim, tengra, gazar, tatkini and various species of prawn. During the water recession period a number of "fixed engine" (locally known as shuti jal) are operated in the old Atrai River and Panullal khal. Similarly, in their study at Chanda beel, they reported fishing gears used including fishing nets made of nylon or cotton twine, bamboo traps, hook and line and spears, while the fish species were caught include major carps as well as others such as, koi, punti, etc.

Chantarasri (1994) reported that about the Sundarbans Reserved Forest (SRF) fishermen community. Fishing was carried out in groups. Most of the fishermen own their fishing gears with which they caught less than 40-kg fish per month. Typically monthly earning was 2000 to 3000 taka.

BCAS (1989) investigated the gear used by fishermen for fishing in the beels of Netrokona and Sunamgoaj district. The gears recorded were jhaki jal, uthur jal, veshal/khora jal, dal jal, kona ber jal, tonma jal, goar jal, pine/pice jal, sarda jal, current jal, ram jalk and chauhunda

jal and in haor areas gears recorded were kochal jal , katha jal, tana jal, koi jal, punti jal, jhaki jal and fash jal.

A rich assortment of traditional fishing gears both active and passive are used by the fishermen in beels (Jhingran, 1989). The big sized catfishes (*Wallago attu*) are generally caught by hook and line. The smaller fishes are bagged by dip nets and cast nets. The gill drag nets are more efficient gears in low weed-infested beels during the winter season. Traps, chiefly made of split bamboo, are extensively used for catching fish in beels.

Rahman *et al.* (1992) recorded 20 species of fish in the catches of punti jal (2.5-3.18 cm mesh) in Borni baor. The composition of dominant species was punti (24.22%), Kholisha (19.68%), shing (16.21%), tengra (8.24%), taki (8.23%), koi (8.07%) and baila (16.12%). But in the catches of koi jal (3.18-3.8 cm, mesh) composed of 15 species and dominant species were punti (25.25%) kholisha (17.42%), shing (17.01%), and koi (15.45%).

Bangladesh supports a diverse set of ecosystems, notwithstanding its relatively small geographical area. It is bounded in the north and the east by the eastern Himalayan and western Myanmar hills, which are centers of plant diversity as well as locations of many biodiversity hotspots (WWF and IUCN 1994-1995). The entire country is biogeographically a transition between the Indo-Gangetic plains and the eastern Himalayas and, in turn, part of the Indo- Chinese sub-region of the Oriental realm.

Biodiversity is an essential resource base for development and livelihood security through provision of biological resources and ecosystem services. Through agriculture, forestry and fisheries biodiversity provides food and fiber; medicine and timber and contributes significantly to national economies and employment. Ecosystems provide essential services including nutrient cycling, air and water purification, flood and drought mitigation, and soil recuperation. These services cannot always be measured in terms of money alone (WRI, 2002).

Chapter 3

Materials and Methods

3.1. Study Area

The study was conducted at Barni baor and Madhumati baor in Gopalganj district. Barni baor is situated at Tungipara upazilla in Gopalganj district. This water body is extended at Barni, Kushli, Mittikabati and Gimadanga mouja in Tungipara upazilla. This baor falls in two unions (Borashi and Raghunathpur) of Gopalganj Sadar Upazila which comprises 20% and in another two unions (Kulshi and Barni) of Tungipara Upazila which comprises about 80% of the baor area. It is about 15 km north-west to Gopalganj sadar upozilla.

Madhumati baor: It is another prominent baor in Gopalganj district. This water body is located 10 km south-west to Kashiani sadar upozilla and it falls in Tarail and Fukra union.

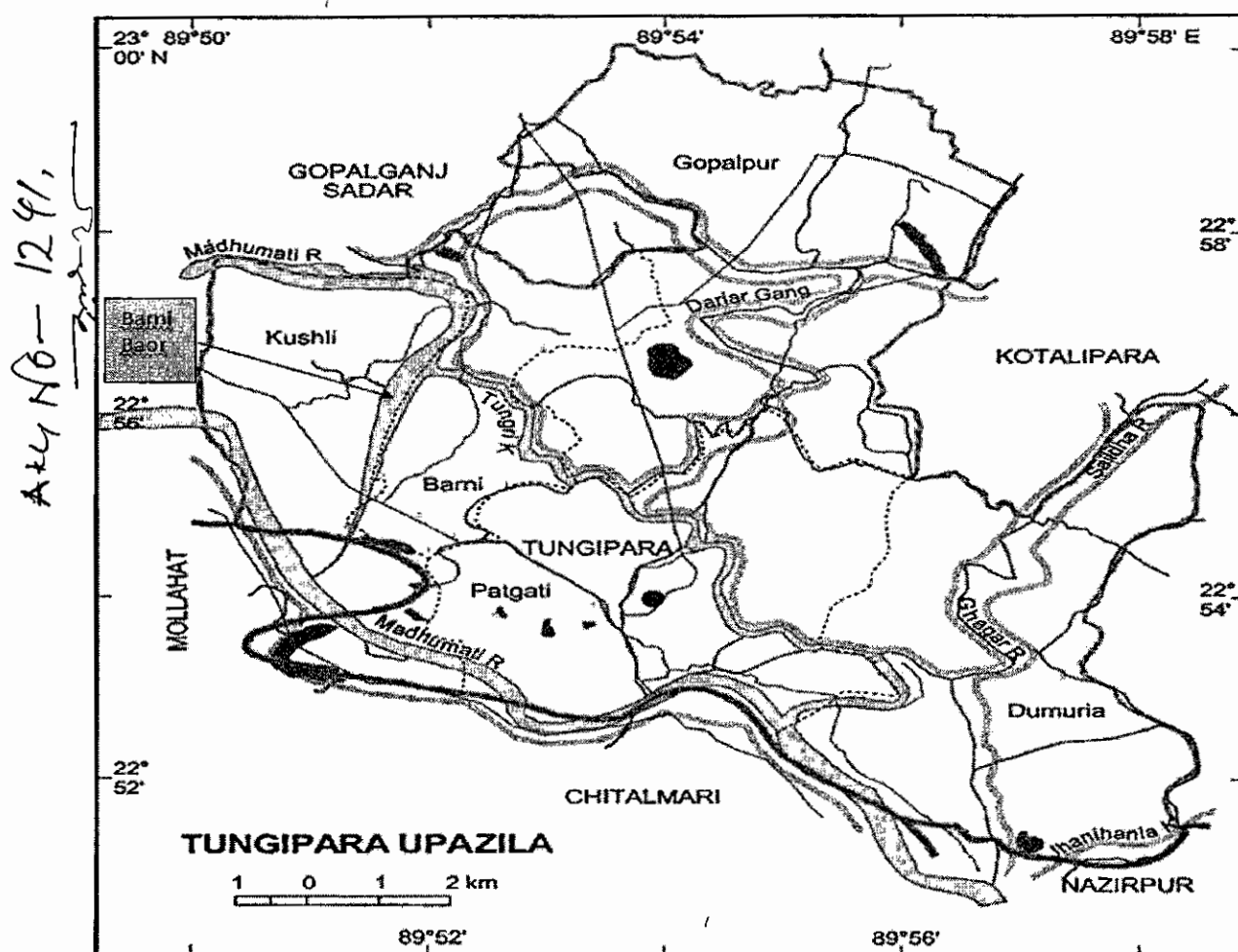


Figure 1: Barni baor in the map of Tungipara upazila.

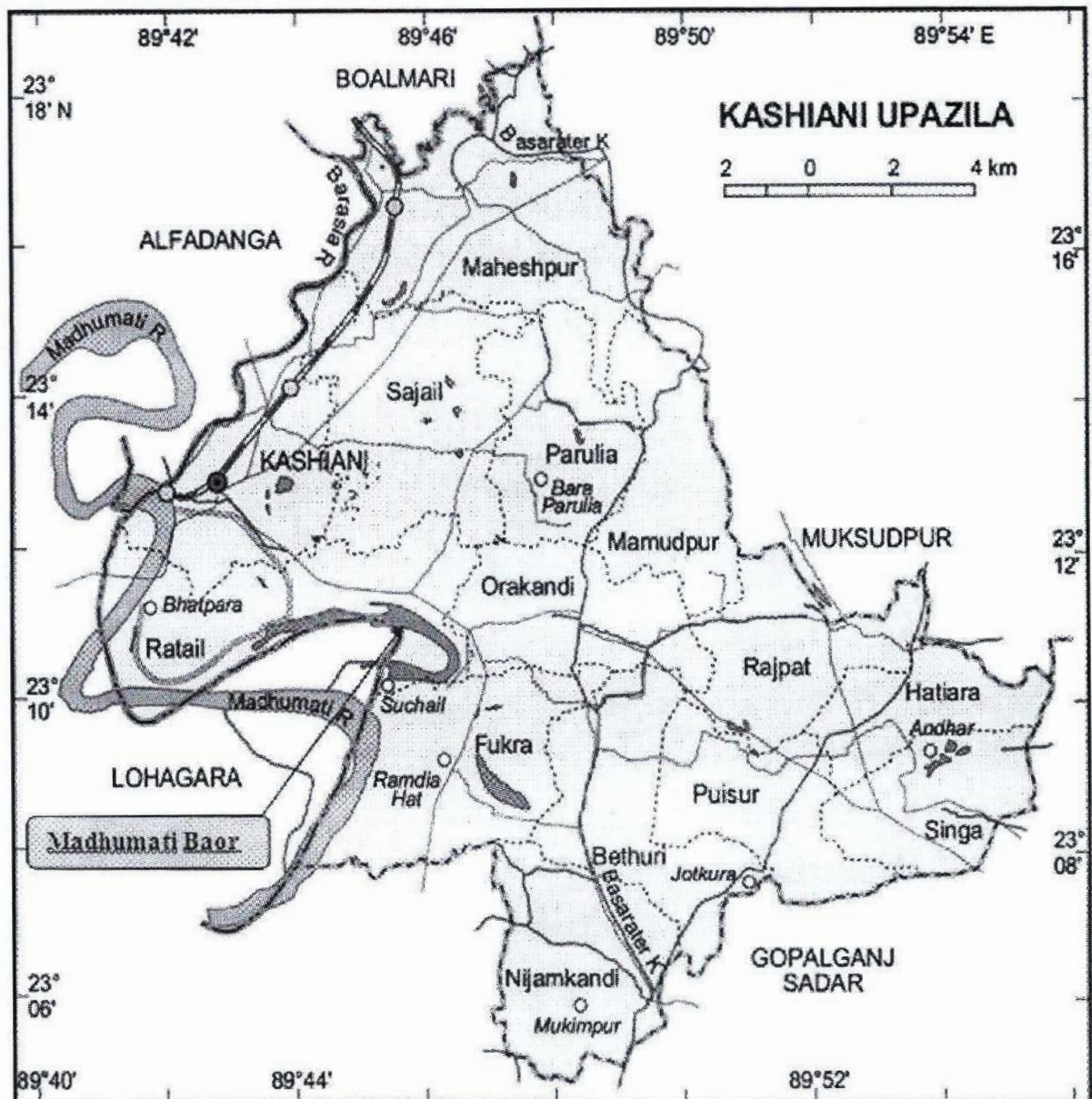


Figure 2: Madhumati baor in the map of Kashiani upazilla, Gopalganj.

3.2. Study period

The survey was conducted from January to November, 2011.

3.3. Water quality Parameters Determination

Among the water quality parameters free carbon-dioxide, dissolved oxygen, alkalinity, salinity and temperature were determined in a year. For these purpose following methods was applied.



Table 1: List of methods for water quality determination

Water quality parameter	Name of method
Free carbon dioxide	Neutralization titration
Dissolved oxygen	Winkler method
Alkalinity	Neutralization titration
Salinity	Using Refractometer
Temperature	Using Thermometer
pH	Using pH test paper

3.2. Collection of Data

To collect relevant data on fishing, catch composition, gear composition, biodiversity and other related data of the selected water bodies, preparation of questionnaire is very important. Before preparing the final questionnaire, a draft questionnaire was developed keeping in view of the objectives of the study. The draft questionnaire was pre-tested in the study area by interviewing a few fishermen and local people by the researcher himself. The questionnaire was then changed, modified and rearranged according to the experience gather in the testing. To know about the ecological parameters both field work and lab-based work was done. (Annex-1). In order to fulfill the objectives of this study, relevant information and literature were collected from the two sources, these are as follows:

3.3.1 Primary source

The primary data were assembled through field survey at the study area by using a structural questionnaire. Data on fishermen activities were collected both by physically observation and interview with farmers at the both oxbow lake side throughout the culture period. Technological issues were asked to fish farmer as per the questionnaire. The water quality parameters like dissolved oxygen, alkalinity, temperature etc through field work and lab-based work.

3.3.2 Secondary sources

Necessary relevant information on culture and management system, production, ecological variation with seasonal variation, information on the biodiversity of the study area and its change with the passage of time, problems in management and possible measures to overcome these problems etc were collected from Tungipara Upazilla fisheries Office, fishermen and local people involved in those baor fisheries, Department of Fisheries and Bangladesh Bureau of Statistics (BBS), Internet. Prescribed questionnaires were also used to collect the secondary information.

3.4. Data analysis

The data obtained from questionnaire survey and practical work were grouped, categorized and interpreted according to the objectives, as well as the indicators. Some data contained numeric while other contained narrative facts. For measurable and indicative answer data have been grouped in tabular forms. All the collected information obtained from the study area were accumulated and analyzed. All statistical analysis were done by using Microsoft Excel in computer and presented graphically.

Chapter-4

Results and Discussion

4.1. Physical structure of Borni Baor and Madhumati Baor

The physical structure of any fisheries system is very important for its management type and biodiversity conservation. The general information on physical condition of Barni Baor and Madhumati Baor is shown in Table-2.

Table 2: Physical structure of Barni Baor and Madhumati Baor

Sl. No.	Characters	Borni Baor	Madhumati Baor
1	Area (ha.)	121.45	191
2	Average depth (m)	2.5	3.0
3	Connecting canal with river	2	1
4	Surrounding villages (no.)	8	7
5	Sluice gate (no.)	1	0
6	Fish landing centre (no.)	2	1
7	Fish Sanctuary	2	3

Barni baor: It is a freshwater marsh in a dead arm of the Madhumati River, connected to the river by two narrow canals – Bashoria canal and Enam fakir canal. The area of this water body is 121.45 ha in dry season but it turns into around 150 ha with its floodplain during the rainy season. Its average depth is about 2.00 m during the dry season and 3.00 m in the rainy season.

Madhumati baor: It is another prominent baor in south west region of Bangladesh situated at Kashiani upazilla under Gopalganj district. This water body is located 10 km south-west to Kashiani sadar upozilla and it falls in Tarail and Fukra union. Its area is approximately 191 ha of permanent inland waters and over 250 ha of land liable to flooding during the monsoon and average depth is around 3m.

4.2. Water quality parameters

For fish culture in inland open water like baor, the maintenance of water quality is not so easy because of its vast area. But the common and important parameters should be in optimum level.

The limnological parameters of the studied areas represent typical tropical conditions, although the winters are relatively cool. The mean annual ranges of the water quality parameters of Barni Baor are as follows: (i) water temperature ($23 \pm 3.2^\circ\text{C}$); (ii) water transparency ($30 \pm 3.37\text{cm}$); (iii) pH (7 ± 1.2); (iv) dissolved oxygen concentration (7 ± 0.5 p.p.m.); (v) carbonate alkalinity (10 ± 0.2 p.p.m.) (vi) Salinity (1 ± 0.5 p.p.t.).

The water quality parameters of Madhumati baor are as follows (i) water temperature ($22 \pm 2.6^\circ\text{C}$); (ii) water transparency ($28 \pm 2.93\text{cm}$); (iv) pH (6.5 ± 1.1); (v) dissolved oxygen concentration (6.1 ± 1.2 p.p.m.); (vi) free carbon dioxide ($1.3\text{--}12.3$ p.p.m.); (vii) carbonate alkalinity (8 ± 0.31 p.p.m.) (vii) Salinity (1 ± 0.6 p.p.t.).

The water quality parameters of the two baors were determined during a year and the results are shown in following tables.

Table 3: Water quality parameter of Borni baor and Madhumati baor

Water parameter	Borni baor	Madhumati baor
Temperature	$23 \pm 3.2^\circ\text{C}$	$22 \pm 2.6^\circ\text{C}$
Water transparency	$30 \pm 3.37\text{cm}$	$28 \pm 2.93\text{cm}$
pH	7 ± 1.2	6.5 ± 1.1
Dissolved oxygen	7 ± 0.5 p.p.m.	6.1 ± 1.2 p.p.m.
Carbonate alkalinity	10 ± 0.2 p.p.m.	8 ± 0.31 p.p.m.
Salinity	1 ± 0.5 p.p.t.	1 ± 0.6 p.p.t.

Habitat degradation: The habitat loss is perceived by agriculture field by the water bodies. Once the agriculture-land by the baors was under water but now they have been turned into agriculture land and this process is continuing. As a result total area of the baors is decreasing. It has been observed that the area and depth of these water bodies are decreasing day by day because of its siltation problem. This problem is more serious in Madhumati baor than that of Barni baor. During tidal flow silt enters into these water bodies and settles down

on the bottom which causes habitat loss for aquatic organism. In case of Madhumati baor there is only one connecting canal with the river so silt and other materials with tidal flow enter into the baor but they cannot derive out of the baor and settle on the bottom. Due to this siltation problem, around 1 ha water body is lost in Madhumati baor every year but it is not so severe in Borni baor. In Borni baor there is two connecting canal at two opposite side. So during tidal a little amount of silt settle down and most of them derive away another canal.

All the water quality parameters change within a range all the year round except salinity and these change does not affect severely on fish-production. The salinity of the water body remains approximately 0 p.p.t. but in March-April it ranges between 0 to 1 p.p.t. and it affects the biodiversity of fresh water. Tsai *et. al.* (1984) reported that the biodiversity and seasonal production of a freshwater is greatly affected by intrusion of salt water. Though other water quality parameters change with season but they cannot affect so much on its environment and its biodiversity. Sometimes water is polluted by pesticides, insecticides, chemicals used in agriculture field just by the water bodies and domestic wastage.

Due to carelessness aquatic weeds grow in the water body. We know that the production performance of these weeds is very much. Water hyacinth is one type of aquatic weeds. It spreads over the water body. In this reason sun light cannot enter into the water.

The farmers practice jute rotting in the baor water. As a result the water becomes polluted. In the summer season the farmers irrigate water in their paddy field. As a result the baor water reduced.

4.3. Fish Biodiversity of Borni Baor and Madhumati Baor

The Convention on Biological Diversity (CBD) defines biodiversity as “the variability among living organisms from all sources including, *inter alia*, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems”.



Biodiversity refers to the abundance and variety within and among flora and fauna as well as the ecosystem and ecological process to which they belong, and thus usually considered at ecosystem; species diversity is concerned with the variety of habitats and communities, as well as the ecological process within ecosystem.

Biodiversity helps keep ecological balance as well as provides a source of human food. The biodiversity of Bangladesh inland fresh water is so rich. Inland fresh water body of Bangladesh comprises about 260 fresh water fish species and some other aquatic plants which have a nutritional value as well as economic importance (Habib, 1999). The study areas Barni Baor and Madhumati Baor are not exceptional to that. Both of them comprise approximately all of the fresh water fish species those are available in inland water bodies of Bangladesh. The fish biodiversity of the two water bodies are as follows.

Fish biodiversity of Barni baor:

A one-year survey has been conducted on the studied areas; various information was collected from local fishermen and Thana Fisheries Office, DoF. The study revealed that at present there are about 33 species of indigenous fish are available in Barni baor. Some species are stocked in the water body. Stocked fish in 2011 are Catla, Rui, Mrigal etc. It was also been observed that five species are in endangered condition and three species are possibly extinct from the baor. The description of fish biodiversity of Borni baor is as follows.

Table 4: Checklist of stocked fish species in Barni Baor (Source: UFO & Survey)

SL NO.	Scientific Name	Local name
1.	<i>Catla catla</i>	Catla
2.	<i>Labeo rohita</i>	Rui
3.	<i>Cirrhinus cirrhosus</i>	Mrigal
4.	<i>Hypophthalmichthys molitrix</i>	Silver carp
5.	<i>Cyprinus carpio</i>	Common carp
6.	<i>Ctenopharyngodon idella</i>	Grass carp

Table 5: Checklist of available indigenous fish species in Barni Baor

Serial No	Scientific Name	Local Name
01.	<i>Amblypharyngodon mola</i>	Mola
02.	<i>Esomus danricus</i>	Darkina
03.	<i>Labeo gonius</i>	Gonia
04.	<i>Puntius sarana</i>	Sar puti
05.	<i>Puntiu ticto</i>	Titputi
06.	<i>Ompok pabda</i>	Pabda
07.	<i>Heteropneustes fossilis</i>	Shing
08.	<i>Liza parsia</i>	Parse
09.	<i>Labeo bata</i>	Bata
10.	<i>Mystus vittatus</i>	Tangra
11.	<i>Labeo nandina</i>	Nandina
12.	<i>Labeo boga</i>	Bhangan
13.	<i>Puntius sophore</i>	Jatiputi
14.	<i>Ailia coila</i>	Kajoli
15.	<i>Labeo calbasu</i>	Kalibaush
16.	<i>Mystus aor</i>	Air
17.	<i>Mystus. gulio</i>	Nuna – tengra
18.	<i>Pungasius pungasius</i>	Pungas
19.	<i>Anabas testudineus</i>	Koi
20.	<i>Channa striatus</i>	Shol
21.	<i>Channa punctatus</i>	Taki
22.	<i>Canna marulius</i>	Gozar
23.	<i>Colissa fasciatus</i>	Kholisha
24.	<i>Tetraodon cutcutia</i>	Tepa
25.	<i>Clarius batrachus</i>	Magur
26.	<i>Glossogobius giurius</i>	Bele
27.	<i>Puntius ticto</i>	Titpunti
28.	<i>Ompok bimaculatus</i>	Kani pabda
29.	<i>Ompok pabda</i>	Madhu pabda

30.	<i>Mastacembelus armatus</i>	Tara bain
31.	<i>Macrogathus pancalus</i>	Pakhál
32.	<i>Salmostoma bacaila</i>	Narkalichela
33.	<i>Nandus nandus</i>	Meni/Roina

Table 6: Checklist of endangered fish species in Barni Baor

SL NO.	Scientific Name	Local name
1.	<i>Notopterus chitala</i>	Chital
2.	<i>Notopterus Notopterus</i>	Foli
3.	<i>Cirrhinus reba</i>	Tatkani
4.	<i>Channa orientalis</i>	Cheng
5.	<i>Chanda nama</i>	Chanda

Table 7: Checklist of extinct (possibly) fish species from Barni baor:

SL NO.	Scientific Name	Local name
1.	<i>Clupisoma garua</i>	Gharua
2.	<i>Gudusia chapra</i>	Chapila
3.	<i>Rita rita</i>	Rita

Fish biodiversity of Madhumati baor:

Madhumati baor contains most of the fish species which belong to Borni baor but some exception. Some valuable indigenous fish species that were once available in large volumes are currently under threat and severely depleted from Madhumati baor. At the time of study there are 41 species of indigenous fish found in the Madhumati Baor. Five species are in endangered condition and two species are thought to be extinct from the water body. The scenario of fish biodiversity of Madhumati baor is listed below.

Table 8: Checklist of stocked fish species in Madhumati Baor

SL NO.	Scientific Name	Local name
1.	<i>Catla catla</i>	Catla

2.	<i>Labeo rohita</i>	Rui
3.	<i>Cirrhinus cirrhosus</i>	Mrigal
4.	<i>Hypophthalmichthys molitrix</i>	Silver carp
5.	<i>Ciprinus carpio</i>	Common carp
6.	<i>Ctenopharyngodon idella</i>	Grass carp
7.	<i>Puntius gonionotus</i>	Thai sarapunti

Table 9: Checklist of available indigenous fish species in Madhumati Baor

Serial No	Scientific Name	Local Name
01.	<i>Anabas testudineus</i>	Koi
02.	<i>Esomus danricus</i>	Darkina
03.	<i>Labeo gonius</i>	Gonia
04.	<i>Puntius sarana</i>	Sar puti
05.	<i>Puntiu ticto</i>	Titputi
06.	<i>Ompok pabda</i>	Pabda
07.	<i>Heteropneustes fossilis</i>	Shing
08.	<i>Liza parsia</i>	Parse
09.	<i>Labeo bata</i>	Bata
10.	<i>Labeo nandina</i>	Nandina
11.	<i>Wallago attu</i>	Boal
12.	<i>Puntius sophore</i>	Jatiputi
13.	<i>Ailia coila</i>	Kajoli
14.	<i>Labeo calbasu</i>	Kalibaush
15.	<i>Mystus aor</i>	Air
16.	<i>Mystus. gulio</i>	Nuna – tengra
17.	<i>Pungasius pungasius</i>	Pungas
18.	<i>Amblypharyngodon mola</i>	Mola
19.	<i>Channa striatus</i>	Shol
20.	<i>Channa orientalis</i>	Cheng
21.	<i>Channa punctatus</i>	Taki

22.	<i>Channa marulius</i>	Gozar
23.	<i>Colissa fasciatus</i>	Kholisha
24.	<i>Tetraodon cutcutia</i>	Tepa
25.	<i>Clarius batrachus</i>	Magur
26.	<i>Glossogobius giurius</i>	Bele
27.	<i>Channa barca</i>	Tila shol
28.	<i>Ompok bimaculatus</i>	Kani pabda
29.	<i>Ompok pabda</i>	Madhu pabda
30.	<i>Mastacembelus armatus</i>	Tara baim
31.	<i>Mastacembelus pancalus</i>	Pakhal
32.	<i>Mystus bleekeri</i>	Gulsha tengara
33.	<i>Nandus nandus</i>	Meni/veda
34.	<i>Cirrhinus reba</i>	Tatkani
35.	<i>Mystus tengara</i>	Kalo Buzuri
36.	<i>Mystus vittatus</i>	Tangra
37.	<i>Mystus gulio</i>	Nuna-tengra
38.	<i>Xenentodon cancila</i>	Kakila
39.	<i>Colisa lalius</i>	Lal khalisha;
40.	<i>Lepidocephalus guntia</i>	Puiya; Gutum
41.	<i>Chanda nama</i>	Chanda



Table 10: Checklist of endangered fish species in Madhumati Baor

SL NO.	Scientific Name	Local name
1.	<i>Notopterus chitala</i>	Chital
2.	<i>Notopterus Notopterus</i>	Foli
3.	<i>Rita rita</i>	Rita
4.	<i>Clupisoma garua</i>	Gharua

Table 11: Checklist of extinct (possibly) fish species from Madhumati baor:

SL NO.	Scientific Name	Local name
1.	<i>Gudusia chapra</i>	Chapila
2.	<i>Labeo boga</i>	Bhangan

**Source: TFO, DoF and field survey*

The study revealed that fish species diversity in those baors are not so developed because they contain a few fresh water species out of 260 fresh water species of Bangladesh. Moreover it is regretful that some species are about to be extinct and some are threatened.

Causes of biodiversity degradation in those water bodies are –

Salinity: The intrusion of saline water due to tidal flow during March-April is a major threat to the biodiversity of the baors. Usually the salinity of the baors remains at 0 p.p.t. But in this time the salinity of these water bodies ranges between 0-1 p.p.t. and it causes a great harm to the production of freshwater fish species and its biodiversity.

Siltation: The area and depth of these water bodies are decreasing day by day because of its siltation problem. This problem is more serious in Madhumati baor than that of Borni baor. During tidal flow silt enters into these water bodies and settles down on the bottom which causes habitat loss for aquatic organism. Due to this siltation problem, around 1 ha water body is lost in Madhumati baor every year but it is not so severe in Borni baor.

Pollution: The use of insecticides, pesticides (Thiodine, Basodine, Furadan, Kuratar etc.) and other chemicals in the agriculture fields just by these water bodies cause pollution to it. These are washed away to the baor and affect its environment and biodiversity. Sometimes domestic wastage pollutes these water bodies.

Overfishing: It is another major problem in these water bodies. People dependent on this resources catch fish indiscriminately even in breeding season of fish. It hinders maximum production and its sustainable development

Illegal fishing: Some fishermen involved in these water bodies use some prohibited gears and catch fish from fish sanctuary and practice fishing during breeding season. Such type of illegal fishing hampers the production as well as its biodiversity.

Disease: Usually in the winter season the fish suffer from ulcer disease. It reduces the quality of fish product, production and threatens biodiversity.

Excess growth of aquatic weeds and water hyacinth: Due to carelessness aquatic weeds grow in the water body. We know that the production performance of these weeds is very much. Water hyacinth is one type of aquatic weeds. It spreads over the water body. In this reason sun light cannot enter into the water.

Jute rotting: The farmers rotting their jute in the baor water. As a result the water becomes polluted affects the survival of fish.

Water irrigate for rice farming: In the summer season the farmers irrigate water in their paddy field. As a result the baor water reduced and affects its fish production and survivality.

Principal vegetation: Aquatic weeds in water body have both positive and negative impact on fish biodiversity. Sometimes they are used as food for fish or may be used as human food. Aquatic vegetation acts as a shelter for fish and protects them from sun. The principal aquatic vegetation in those water bodies include the followin species

Table 12: Principal aquatic vegetation in Barni and Madhumati baor (Source: UFO & Field Survey)

SL NO.	Scientific Name	Local name
01.	<i>Ipomoea aquatica</i>	Kalmi lata
02.	<i>Atternanthera philokeroides</i>	Malancha
03.	<i>Echhornia erassipes.</i>	Chosuri pana

04.	<i>Hydrolea zeylanica</i>	Rashchora
05.	<i>Vallisneria spirafits</i>	Pata sheeola.
06.	<i>Nymphyea nauchali.</i>	Shapla
07.	<i>Salvinia natans</i>	Tilok pana.
08.	<i>Trapa leispinosa</i>	Panifall, singara
09.	<i>Xanthium indicum</i>	Khagra
10.	<i>Jussicea resells</i>	Keshordam
11.	<i>Potamogeton nodusus</i>	Jalpippali.

4.4 Fisheries management system: No effective government management system is prevailing at the water bodies now. It has been known from interviewing with the people's that now-a-days the baors are conducted by the rule "Jal jar-jola tar" i.e. fishermen are owner of the water bodies. Fish larvae especially fingerlings of Rui, Catla, Mrigal and some other fast growing species are stocked. The indigenous fish species like Koi, Shol, Taki, Gojar, Bain, Punti, Sarpunti, Foli, Tatkani, Bailla, Meni, Pabda, Boal, Goldachingri, Ichachingri etc. are available in these water bodies but now-a-days production of Sarpunti, Foli, Rayek, and Golda has decreased alarmingly. Borni baor was conducted through leasing system and the govt. would take Tk. 10, 00,000 revenue from this water body. During the visit of Prime minister Sheikh Hasina on April 04, 1998 she ordered to run Barni baor according to the rule "Jal jar-Jola tar" i.e. fishermen are the owner of this resources and it is still conducted by the same rule.

About 8 years ago Madhumati Baor was managed under leasing system. But the present scenario of management is completely different from the previous system. Today the local persons who are politically influential manage the resources according to their own will. So the real fishermen are being deprived from their legal share of this resource. The only developmental activities in this water body are to stock fish fry in monsoon and implementation of fisheries rules and regulations legislated by govt. But implementation of the regulation is not so effective.

Fish Stocking

Artificial stocking has proven one of the successful beel/baor fisheries enhancement and management. The biophysical and economic basis behind artificial stocking is to maximize use of the trophic levels by stocked fish that eat and control macrophytes and green algae to enhance fish production. So, species to be stocked would be selected on the basis of ability to exploit the available ecological niches in the water body. The introduction of carp and exotic species to the natural closed/semi-closed water bodies has resulted in competition for food and space and ultimately in the decline of indigenous species. Carp such as Catla (*Catla catla*), Rohu (*Labeo rohita*) and Mrigal (*Cyrrhinus mrigala*) and exotic species such as Silver carp, Grass carp, common carp, have been cultured in these baors.

For ensuring better production, appropriate species selection is a must. Species should be selected in such a way that they can occupy the unused space of food chain so that competition between species for food and space would be minimized. For these a considerable number of species are selected to use available space in a habitat. Species are selected to use available space in top, mid and bottom layer of the water column.

The water bodies were stocked with carp each year. Stocking period of two water bodies were different. Stocking are accomplished in February to March in Borni baor and July to August in Madhumati baor.

It was found that single stocking of carps with a density of 200 kg/ha (6-8 cm in length) with an appropriate species composition ratio does not affect yield of non-stocked indigenous fish when compared with no carp stocking (CBFM, 2003).

In present study, stocking density of Borni baor is about 30 kg/ha and in Madhumati baor is about 25 kg/ha (Table-4). In Borni baor, six species of fish such as rohu (*Labeo rohita*), Catla (*Catla catla*) mrigal (*Cirrhinus mrigala*), silver carp (*Hypophthalmichthys molitrix*), grass carp (*Ctenopharyngodon idella*), and common carp (*Cyprinus carpio*) were stocked, while in Madhumati baor stocked seven species of fish such as rohu (*Labeo rohita*), Catla (*Catla catla*) mrigal (*Cirrhinus mrigala*), silver carp (*Hypophthalmichthys molitrix*), grass

carp (*Ctenopharyngodon idella*), common carp (*Cyprinus carpio*) and Thai sharputi (*Puntius gonionotus*). The stocking density and species ratios in the present study, shown in Table-13.

Table 13: General information of stocking in Barni Baor and Madhumati Baor (UFO)

	Barni Baor	Madhumati Baor
Stocking period	February-March	July – August
Selected species		
Carp	Rohu , Catla, Mrigel	Rohu , Catla, Mrigel,
Exotic carp	Silver carp, grass carp, common carp	Silver carp, grass carp, common carp, Thai sarputi
Species number	06	07
Total stocking	3600 kg	4775 kg
Stocking density	30 kg/ha	25 kg/ha

Source: Field survey 2010-11



Fish sanctuary: Fish sanctuary is a sacred and defined place in a water body or habitat where fish can breed easily to maintain their perpetuity and save themselves from any adverse effect. Generally it is a definite place where fishing is prohibited for a certain time or all the year round. There are four fish sanctuaries in Borni baor. Two of them are located near Nokrirchar and others are located Borni and Perkushli. All the sanctuary covers around 10 ha.

In Madhumati baor there are three sanctuaries- located near Ratoil and Tarail. These sanctuaries cover around 8 ha of its inland water body. Fishing in these sanctuaries is prohibited all the year round and these play an important role of its biodiversity conservation.

Fishing methods

There are three types of fishing methods are found in Barni baor and two types in Madhumati baor water bodies. Kochal, Komor and Chak fishing was practiced for fishing in Barni baor

and Kochal and Komor fishing was practiced in Madhumati baor. Kochal, Komor and Chak fishing system are used to harvest stocked carp in the water bodies.

Kochal fishing was practiced for fishing of the stocked carps in Barni baor and madhumati baor. The method consisted of seine net, mainly operated for harvesting the silver carps and catla.

Komor fishing or drag netting is principally adopted as a device to catch the remaining in the water body after the completion of kochal fishing. The density of the fish population in the water body get reduced after kochal fishing, the remaining fish after driven by the kochal operation take shelter in the brush parks set nearby in the areas. It has been seen that Catla and Silver carp are mainly caught by kochal fishing; the comparatively bigger ones of Catla and Silver carps can escape the kochal and take shelter in the komors. Also, Rohu, Mrigal and common carps, who feed in the column and in the bottom areas can escape large and hide in the brush parks. As a result of the harvest from komors, principally consist of bigger Catla and silver carps and varied size of rohu, mrigal and common carps. It has been found that under Barni baor maximum komor fishing was done.

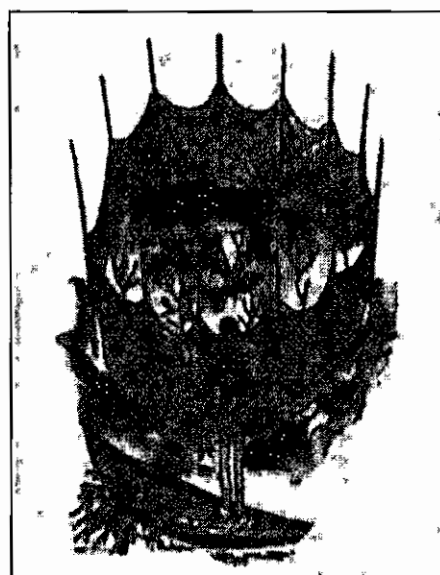


Figure 3: A. Kochal

B. Komor

It has been said in the foregoing that chak is a selective gear for fishing in areas that are comparatively shallower and with dense vegetation. These conditions do not allow fishing with kochal. However, often the principal species caught by chak jal are rohu, mrigel and common carps. During the investigation chak fishing was only reported from BORNI BAOR.

5. Gears used in fishing

Various types of fishing gear were found to operate in the water bodies where most of the gears were traditional and few of them were unique. From the survey a total of 11 types of gear were recorded operational in baors area.

i. Gill net

This net is rectangular with single wall which is made of synthetic or cotton twine with a head rope but with or without ground rope. Floats are attached with head rope while the ground rope may or may not have sinkers. This net is fixed by poles in all depth of water during operation. The size of this net varies from 5 to 10 m and mesh size varies from 2 to 5 cm.

ii. Seine net

The net is also called *Ber jal* or Shore seine net. The net is about 150- 300 m long and 1.8-4.5 m height. The mesh size is 1.2-2.5 cm stretched and is made of multifilament fiber. The net is set from a boat in area and pulled to shore by 4-6 fishermen.

iii. Push net

The net is triangular in outline. Two bamboo poles, one longer than the other, are fixed at an angle of about 30 degrees. The longer portion of one of the poles is used as a handle. To the triangle the net is fastened. During operation the triangular portion of the net is lowered and is pushed forwarded over the bottom of water to a certain distance and lifted on to collect fish.

iv. Set bag net

It is also known as *Behundi jal*. The shape of the net is like an elongate tapering funnel. The mouth opening is rectangular and held open by two vertical bamboo poles. The mesh size of the net decrease towards the bag end side. At the mouth opening the mesh size is about 5 inch where at the bag end it is only about 1.25 inch. The length of the net, width of the mouth and height of the mouth varies at different area. The net is placed in the tidal stream and catches fish with the tidal current and passively swift in to the net.

v. Large lift net

This net is fastened at the corners of four diagonal, bent, and split bamboo poles. The lift pole is tied at the centre of the crossed bamboo poles and is handled like lever to the net from the water. In addition to the bamboo handle, occasionally a rope is used to facilitate the manipulation of the net. This net is operated in shallow water in low current and standing water.

vi. Small lift net

This net is fastened at the corners of four diagonal, bent, and split bamboo poles. The lift pole is tied at the centre of the crossed bamboo poles and is handled like lever to the net from the water. In addition to the bamboo handle, occasionally a rope is used to facilitate the manipulation of the net. This net is operated in shallow water in low current and standing water.

vii. Cast net

It is a conical shaped net with variable size. The hauling string of the net is fixed at the narrow apical end of the cone. The lower end is folded, doubled up and attached to the net at intervals to form a series of pockets. The margins of pockets are provided with iron weight sinkers. This net is thrown into the shallow or moderately deep water from the shore bank or moving boat. As soon as it is thrown, it goes down quickly due to the weight of the sinkers.

viii. Long line

It is also called *Don borshi*, *hatari borshi*, *dom borshi* or *charra borshi*. The gear is consisted of a main line of about 500 ft long to which short lines with hooks are tied. It may have 300-800 hooks which are set with the baits. One end of the main line is tied to a tree of the water.

ix. Trap

a. Bair: It is a tubular shaped basket like trap. The bamboo sticks are arranged in parallel one after another and tied them with cane materials or wire. Usually bamboo plates are used to make the structure of this gear. There is a unidirectional valve at the mouth and single opening at the upper side. It is mainly operated in shallow running water and set against the water current. Fish once entered through this valve cannot escape.

b. Hogra: It is made of thin bamboo plates arranged serially as a sieve. The structure is a triangular once with a pocket at the posterior end. It is used in shallow running water. Some tree branches are put inside which act as hiding place for fish. After certain interval it is pulled above the water surface (or pulled up) and the trapped fishes are collected.

Fish production: As there is no effective management system in the baors so there is no exact information on the production from these water bodies. But every year a rough estimation was determined by upozilla fisheries officer through observing some criteria such as fish stocking, fish harvesting, fish growth, gear efficiency etc. by fishermen. The amount of fish production from these baors during previous 10 years is as follows.

Table 14: Yearly production of Barni Baor and Madhumati Baor

Year	Production of Borni baor (Kg/ha)	Production of Madhumati baor (Kg/ha)
2001	360	390
2002	380	380
2003	340	370
2004	350	375
2005	320	350
2006	300	340

2007	250	325
2008	220	330
2009	200	300
2010	180	245

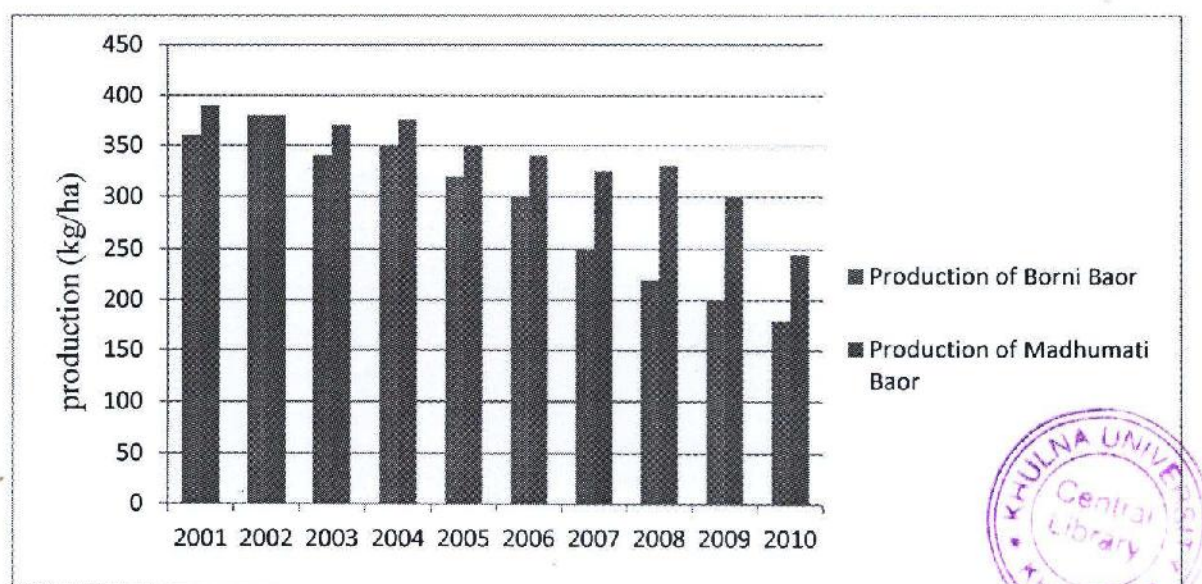


Figure 4: Graphical representation of yearly production and comparison between Barni and Madhumati baor.

The production of these two water bodies has decreased gradually due to loss of habitat through siltation and not to have other developmental activities. Sometimes water quality deteriorates due to natural disasters and other anthropogenic activities such as use of insecticides, pesticides, other chemicals in surrounding agriculture field. Production rate was higher in 2001. From then production rate has been decreasing and this trend is going on. Fry stocking and implementation of fisheries rules and regulations are not strictly maintained. Agrwal (2001) reported that proper and scientific management of any resources increase its output and make it sustainable for future management. But in the two water bodies there is no sustainable management system so its production and biodiversity has been decreasing. In comparison of production rate Madhumati baor is higher than Barni. Area of the water bodies is responsible behind this variation. The area of Madhumati baor is higher than that of Barni baor and other parameters do not differ greatly from one another so the production of Madhumati baor is higher than that of Barni baor. Sometimes overfishing or fishing of brood

fish in breeding season hamper the production of next year. Such types of fishing are frequently done in both baors. It is another cause of degradation of production. Per capita income of the fishermen dependent on these resources is on degradation. The production of Barni baor is greater than that of Madhumati baor. Degradation of fish species diversity is another cause of this variation in production.

Chapter-5

Problems

6.1 Problem of these Baors:

These baors are prominent baors in Bangladesh. The development of this baors plays a vital role in our national economy that helps to increase our GDP. But there are some problems of these baors to manage it and its development. These are given below-

- i. **Salinity:** The intrusion of saline water during March-April is a major threat to the biodiversity of the baors. Usually the salinity of the baors remains at 0 p.p.t. But in this time the salinity of these water bodies ranges between 0-1 p.p.t. and it causes a great loss to the production of freshwater fish species and its biodiversity.
- ii. **Siltation:** The area and depth of these water bodies are decreasing day by day because of its siltation problem. This problem is more serious in Madhumati baor than that of Borni baor. During tidal flow silt enters into these water bodies and settles down on the bottom which causes habitat loss for aquatic organism. Due to this siltation problem, around 1 ha water body is lost in Madhumati baor every year but it is not so severe in Borni baor.
- iii. **Lack of manpower:** To manage a water body like baor sufficient number of trained manpower is required which is absent in both water bodies.
- iv. **Interference of local influential persons:** At present there is no effective govt. management system. So these water bodies are conducted by the local persons who have a little knowledge about management system of baor. The real fishermen are being deprived of their legal share of this resource due to this problem and they are being forced to live under poverty line.

- v. **Violation of fisheries rules and regulation:** The people involved in these baors or the beneficiaries of this resource are not well aware of the fisheries rules and regulations. So they violate the rules at every step to use it. Even the persons who are informed of fisheries rules and regulation transgress the rules for their own interest.
- vi. **Pollution:** The use of insecticides, pesticides and other chemicals in the agriculture fields just by these water bodies cause pollution to it. These are washed away to the baor and affect its environment and biodiversity. Sometimes domestic wastage pollutes these water bodies.
- vii. **Overfishing:** It is another major problem in these water bodies. People dependent on this resources catch fish indiscriminately even in breeding season of fish. It hinders maximum production and its sustainable development.
- viii. **Conflict and chaos among fisherman:** As the law enforcement agency is not so active to manage these resources so the local people become in conflict to use the resource. Such situation hampers the development activities of the water bodies.
- ix. **Illegal fishing:** Some fishermen involved in these water bodies use some prohibited gears and catch fish from fish sanctuary. Such type of illegal fishing hampers the production as well as its biodiversity.
- x. **Disease:** Usually in the winter season the fish suffer from ulcer disease. It reduces the quality of fish product, production and threats biodiversity.
- xi. **Excess growth of aquatic weeds and water hyacinth:** Due to carelessness aquatic weeds grow in the water body. We know that the production performance of these weeds is very much. Water hyacinth is one type of aquatic weeds. It spreads over the water body. In this reason sun light cannot enter into the water.

- xii. **Jute poaching:** The farmers rotting their jute in the baor water. As a result the water becomes polluted.
- xiii. **Water irrigate for rice farming:** In the summer season the farmers irrigate water in their paddy field. As a result the baor water reduced.

Chapter 6

Recommendation

It needs to be emphasized that the future prospect of the country lies in better management of its baors. Baor management in Bangladesh is strongly linked to a specific cluster of socio-economic wages that have emerged in response to age, old interactions between a unique ecosystem and the people who are dependent on it. If suitable management of baor is possible then it will be able to fulfill national protein demand. A number of recommendations for conservation and sustainable use of the studied baors are listed below:

- The baors should be dredged for increasing the water content of the baors.
- License should be allowed for the true fishermen.
- Resource should be properly distributed among the beneficiaries.
- Community based fisheries management should be introduced.
- The baors should not be used for multipurpose.
- Integrated culture should be adopted in the baors.
- Cage or pen culture should be adopted in the baors.
- Local persons and government administration body should be involved to protect poaching and any unexpected situation.
- Establishment of more sanctuaries for endangered and threatened species and their effective management should be ensured.
- The existing legislation relating to baors, which are compatible with national environment policy, should be strictly enforced. Such as
 1. All round habitat improvement by environment planning.
 2. Restriction on overfishing.
 3. Prohibition on juvenile fishing by enforcing the use of proper gear.
 4. Prohibition on fishing of brood fish in a certain period of a year.
 5. Proper assessment of stock.
 6. Establishment of balance between harvest and stock renewal. Introduction of surveillance program to examine the water quality (physio-chemical and biochemical).
 7. Integration between conservation and development.

8. Environmental impact analysis before installation any development project which may adversely affect fishery.
9. Proper care of endangered and depleted species.
10. Restriction on use of poison in fishing.
11. Proper management of watershed.
12. Imposition of regulations conducive to conservation and creation of public awareness.
13. Appropriate conservation and management measures should be adopted in the baors based on scientific evidence.
14. The development of necessary infrastructure, technology and human resource for better exploitation should be given the emphasis.
15. It is important to involve all concerned groups including administration, scientist and fishermen in the process of formulating and implementing management measures for the baors.
16. Environment planning should be conducted for the all around habitat improvement for the fishery resources of the baors.
17. A committee should be formed that will be composed of fishermen, NGO's, industries depend on the fisheries of the baors. Department of fisheries and other concerned institution in order to help control fishery resource exploitation, conservation and management of the baors.
18. Credit facilities for the fishermen should be provided for buying crafts, gears etc.
19. Imposing strict regulation and frequent monitoring should be restricting on overfishing.

Chapter 7

Conclusion

Baor fisheries play an important role in the poverty alleviation of the poor people as well as food protein supply for the country. Barni Baor and Madhumati Baor play an important role in fish production, income generating activities, employment opportunities and socio economic condition of the fishers' community. A few years ago the number of fish species and production rate was higher than that of present situation. Though there are 260 fresh water fish species are available in Bangladesh but the selected baors contain little amount of them which is not satisfactory for such type of water body. Moreover it is regretful that there is no effective management system exists in this area for its sustainable development. Some species are on the verge of extinction and some are in endangered condition. Production rate and diversity of fish are degrading gradually with the passage of time. For this miserable situation some natural and manmade reasons such as over-fishing, siltation, lack of proper management system and less implementation of fisheries rules and regulations are responsible. There are many problems in baor fisheries management. These problems can be solved through the application of scientific culture, technology, community based fisheries management. Consequently, the fish production will be increased and the livelihood status of that fishers' community will be improved. And this should be done for the welfare of the people dependent on these resource as well as for economic development of our country.



Chapter-8

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Appendix

Questionnaire

1. Name of the baor:
2. Location:
3. Surrounding villages:
4. Area of the baor:
5. Change of area baor during rainy season:
6. Depth of the baor at various seasons: a) winter season- b) rainy season-
7. Habitat loss (area loss):
8. Number of fish species available in the baor at present:
9. Indigenous fish species:
10. Number of fish species available in the baor 5 or 10 years ago:
11. Endangered fish species:
12. Extinct fish species during last 10 years:
13. Others fish species of baor:
14. Aquatic weeds in the baor:
15. Water quality deterioration:
16. Pollution:
17. Causes of pollution:
18. Fish disease (name):
19. Affected fish species:
20. Remedy:
21. Management type:
22. Problems faced in baor management:
23. Fish sanctuary:
24. Pattern of fish culture:

25. Major Fish species of baor (fish fry released/ha)

Species	(kg /ha)
Rui	
Catla	
Mrigal	
Silver carp	
Grass carp	
Common carp	

26. Species composition:

Species	Number (%)
Silver carp	
Rohu	
Catla	
Mrigal	
Common carp	
Grass carp	

27. Sources of Fry:

28. Production:

Fiscal Year	Production
2001	
2002	
2003	
2004	
2005	
2006	
2007	
2008	
2009	
2010	

29. Fish harvesting:

- Peak season-
- Off peak season-

30. Harvesting method:

31. Pattern of fish harvesting full ☐ partial ☐



- 32. Number, Types and Size of gear used in harvesting:
- 33. Marketing System:
- 34. Miscellaneous:

Methods for water quality parameters determination:

1. Principle of salinity determination:

While working with brackish water, it often becomes necessary to estimate the salinity of water in terms of total concentration of soluble salts. This is usually expressed as gram of salts per liter of water or ppt (parts per thousand). Salinity such expressed can be calculated fairly accurately from chlorinity or electrical conductivity value of water.

Materials:

- Refractometer

Reagents:

- Distilled water

Procedure:

- At first, the refractometer was calibrated to "0" by distilled water.
- The sample water was then put on the refractometer and the reading was recorded.

2. Experiment Name: Determination of the alkalinity of the water sample by the neutralization titration.

Principle:

Water samples containing measurable OH^- and or CO_3^{2-} ions turn pink to phenolphthalein indicator. This water becomes colorless at pH below 8.4, when titrated with acid to convert these ions to HCO_3^- form. Again, water sample with only HCO_3^- can be titrated to the critical pH level of 5.3 with acid by using yellow to faint orange color change of methyl orange indicator. Both of the indicators are used for determining total alkalinity, expressed as p.p.m. of calcium carbonate (CaCO_3) and also the concentrations of OH^- , CO_3^{2-} and HCO_3^- ions in water samples.

Materials:

- Burette (25ml),
- Pipette (10ml),
- Funnel,
- Conical flask (250),
- Measuring flask(100ml),
- Beaker (250ml),
- Spatula, Burette stand etc.

Reagent:

- H_2SO_4 ,
- Na_2CO_3 ,
- Phenolphthalein indicator,
- Methyl orange indicator.

Reagent Preparation:

- 0.1N H_2SO_4 solution: 2.8ml H_2SO_4 (95-98%, sp gravity=1.84) was taken into 1 liter volumetric flask and diluted it to 1000ml mark of the flask.
- 0.1N Na_2CO_3 solution: 2.65gm Na_2CO_3 was taken into 500ml volumetric flask and diluted it to 500ml mark of the flask.
- Phenolphthalein indicator solution: 2.5gm Phenolphthalein was dissolved into 250ml 95% ethyl alcohol and added 250ml of distilled water.
- Methyl orange indicator solution: 500gm methyl orange free acid powder was dissolved in distilled water and diluted it to 1 liter.

Procedure:

- The burette was rinsed with distilled water and then rinsed with 0.1N H_2SO_4 by pipette.
- The burette was clamped and filled with 0.1N H_2SO_4 solution up to mark.

- The H_2SO_4 was standardized by NaCO_3 solution.
- The sample (10ml) was taken into 250ml of conical flask and added 5 drops of methyl orange indicator solution into it and titrated with 0.1N H_2SO_4 to a light pink (pH 4.5) color as required by the sample composition.

Calculation:

$$\text{Alkalinity, } \text{mgCaCO}_3 / \text{L} = \frac{A \times N \times 50000}{\text{ml Sample}}$$

A = ml standard acid used and N = normality of standard acid.

3. Experiment Name: Determination of the dissolved oxygen (DO) of the water sample by the Winkler method.

Principle:

Manganous (Mn^{2+}) ions form manganous hydroxide (MnOH_2) under highly alkaline condition. This MnOH_2 reacts with DO of water and an equivalent amount of Mn^{+2} is oxidized to higher valency states. On acidification, in presence of iodide, the oxidized manganous (Mn^{+4}) again reverts to divalent Mn^{+2} and iodide is liberated in equivalent amount of DO. This I_2 estimated by titration with sodium thiosulphate ($\text{Na}_2\text{S}_2\text{O}_3$) indicates the amount of DO in water sample.

Materials:

- Manganous sulfate ($\text{MnSO}_4 \cdot 4\text{H}_2\text{O}$).
- KOH, KI and NaN_3
- Starch and
- Sodium thiosulfate. ($\text{Na}_2\text{S}_2\text{O}_3$)

Procedure:

Laboratory Preparation:

- Manganous sulfate solution: 120gm $\text{MnSO}_4 \cdot 4\text{H}_2\text{O}$ (or 100gm $\text{MnSO}_4 \cdot 2\text{H}_2\text{O}$ or 91gm $\text{MnSO}_4 \cdot \text{H}_2\text{O}$) was dissolved in distilled water and diluted to 250ml.

- Alkali-iodide-acid reagent: For a saturated or less than saturated sample; 700gm KOH and 150gm KI were dissolved in distilled water and diluted to 1L. 10gm NaN_3 was added into it dissolved in 40ml distilled water.
- Starch solution: 2gm laboratory grade soluble starch and 0.2gm salicylic acid were dissolved as a preservative, in 100ml hot distilled water.
- Standard sodium thiosulfate titrant: 6.205gm $\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$ was dissolved in distilled water and 0.4gm NaOH was added and diluted to 100ml.

Field Work:

- 1ml MnSO_4 solution was added followed by 1ml alkali-iodide-azide reagent to the sample collected in a 250 to 300ml BOD bottle.
- The bottle was stoppered carefully to exclude air bubbles and mixed by inverting bottle a few times.
- When precipitate had settled sufficiently to leave clear supernatant above the manganese hydroxide floc, 1.0ml conc. H_2SO_4 was added.
- The bottle was restoppered and mixed by inverting several times until dissolution was completed
- The sample (10ml) was titrated with 0.025 $\text{Na}_2\text{S}_2\text{O}_3$ solutions to pale straw color by adding a few drops of starch solution and continued titration to first disappearance of blue color.

Calculation:

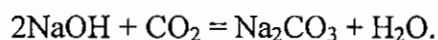
$$\text{DO in } \text{mg/L} = \frac{y \times 200}{x}$$

Here y = ml of the titrant and x = ml of the sample.

4. Experiment Name: Determination of the free CO_2 of the water sample by neutralization titration.

Principle:

Waters having more than 8.3 pH does not contain appreciable amount of free CO_2 . Therefore, phenolphthalein indicator, which has end point at this pH value, is used for estimating the amount of free CO_2 in a water sample for titration with a standard alkali.



Materials:

- ♦ Burette (10ml),
- ♦ Pipette (10ml, 25ml),
- ♦ Funnel,
- ♦ Conical flask (250ml),
- ♦ Measuring flask (100),
- ♦ Beaker (250ml),
- ♦ Spatula,
- ♦ Burettes stand etc.

Reagents:

- ♦ NaOH,
- ♦ Phenolphthalein indicator,
- ♦ Standard potassium hydrogen phthalate.

Reagent preparation:

- ♦ NaOH (0.1N) solution: Cautiously 4gm solid NaOH was dissolved in 1000ml volumetric flask and dissolved it by shaking and filled with dilute water to the mark.
- ♦ Standard potassium hydrogen phthalate solution: 10.0±0.5gm potassium hydrogen phthalate (to the nearest mg), was weighted and transferred it to 1L volumetric flask and diluted it to 1000ml.
- ♦ Phenolphthalein indicator solution: 2.5gm Phenolphthalein was dissolved into 250ml 95% ethyl alcohol and added 250ml of distilled water was added to it .

Procedure:

- ♦ The burette was rinsed with distilled water and then rinsed with 0.1N NaOH by pipette.
- ♦ The burette was clamped and filled with 0.1N NaOH solution up to mark.
- ♦ The NaOH solution standardized by standard potassium hydrogen phthalate solution.