WATER MANAGEMENT IN *Penaeus monodon FARMS* IN KHULNA, BANGLADESH: SOME CASE STUDIES

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A Thesis

By

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WATER MANAGEMENT IN *Penaeus monodon* FARMS IN KHULNA, BANGLADESH: SOME CASE STUDIES

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Declaration

Water management in *Penaeus monodon* farms in Khulna, Bangladesh: Some case studies

The results presented in the thesis with the above 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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Session: 2005-2006

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Dedicated

to

My beloved parents

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Abstract

There are many hindrances for good production from shrimp culture. Lack of proper water management in the culture farms is one the principal ones in the greater Khulna areas. Problems of water quality management arise from the uneven pond bottom, heterogeneous pond depths, inappropriate tidal flux at the mouth of the sluice gates, lack of proper supply of water, lack of chance of water exhange in suitable duration and social conflict among the stackholder farmers of a specific farming community in an area. The study was conducted in three areas of Khulna district namely, Paikgacha, Dumuria, and Dacop Upazillas. The rivers Shalta, Teligati and Shibsa are flown beside the three study areas of Kapilmuni in Paikgacha, Shobna in Dumuria and Tildanga in Dacop respectively. The Nasirpur Khal, Katakhali Khal and Kakrabunia khal were the main Khals from where water was supplied in the areas respectively. Data were collected by several visits in the areas. Individual interview of the farmers, Focus Group Discussions with farmers and Key Informants interviews were performed for the purpose. Interview of a total number of 90 farmers, 3 FGDs and 30 KI were covered in the study. The total number of farms were 1504, 304 and 99 and the total numbers of farmers were 1524, 350 and 468 in the three areas respectively. In two study areas, the main khals that supplied water to the farms were leased to the other parties. They erected structures like patta and nets in the canal making hindrances in water flow. This seriously reduced the water level at the last end of the khal. Heavy siltation in the khals raised the bottom of the khals. The farms lying at the far distance could not take or remove water from their farms. There were no separate inlet and outlet canals in the farms. So there had been no water exchange facilities except the adjacent farms with the Khal. Depth range of the farms was 0.5 to 5 ft. in the farms. There were some poultry farms beside the Khal and

many hanging latrines over the khal. These sources of waste polluted the water of the Khal. There were associations of farmers in Paikgacha and Dacop areas but they were not active. Shrimp farms were made without proper planning. To mitigate the problems the main Khals supplying water in the farms have to be kept free from lease. The sub-canals also have to be widened and free for passage of water in the distant farms. At the absence of separate inlet and outlet canals, good water management would largely depend on the cooperation among the farming community and existence of an active association is must.

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List of abbreviations and non-English words

Khals	The canals that are connected to the river with a gate
FGD	Focus Group Discussion
KI	Key Informant
Gher	The bangla name of prawn, shrimp or fish farm
mt	Metric ton
BWDB	Bangladesh Water Development Board
USA	United State of America
DOF	Department of Fisheries
WSSV	White Spot Syndrome Virus
ppt	Parts per thousand

Chapter One
Introduction

Chapter 1

Introduction

1.1 Background of the study

The riverine country, Bangladesh is naturally suitable for fish culture. Blessed with a conductive climate, the country offers immense scope and potential for a considerable increase in fish production. In recent years, aquaculture has become an increasingly important economic activity and is now globally one of the fastest growing food producing sectors.

The Shrimp industry of Bangladesh is one of the most important contributors for economic sustenance at present and is the second largest export commodity of the country. Bangladesh produces 2.5 percent of the global production of shrimp generating more than US$300 million annually. The main cultured species is the tiger shrimp, *Penaeus monodon*, locally known as *bagda*. It is a marine species and cultivated in brackish waters around the world. The shrimp industry provides direct employment to over 600,000 people who in turn support well over 3.5 million dependents (Chandrika, 1998).

The coastal area of Bangladesh is 710 km long stretching from Satkhira to Cox's Bazar. The climatic condition and geographical location of Bangladesh is favorable for culture of black tiger shrimp. The greater Khulna region has the best overall conditions for farming of this species and as such over 75% of the country's shrimp production presently comes from this region. Shrimp plays an important role in the economy of Bangladesh and about 90% of the total incomes from frozen products come from shrimps and prawns (Biswas, 1996).

Bangladesh exports about 30 thousand metric tons of frozen shrimp annually. This figure represents about 6 percent of total annual exports from Bangladesh. About Tk. 0.2153 billion was earned from frozen shrimp export in 2003-04 (Matshyo Pakkho, 2004). It is estimated that over 10 million people are directly or indirectly benefited from the sector.

Shrimp culture in Bangladesh started to develop since late 1960s. At that time there was little local demand and the price of shrimp was consequently very low. The potential of farmed shrimp as a hard currency earner was quickly realized by the private sector and within 10 years, more than 26,000 ha of shrimp ponds were under cultivation. During this period the shrimp farming industry received little or no support from the Bangladesh Government. Only since 1980 with the introduction of the Second Five Year Plan (1980–85) brackish water aquaculture has begun to attain official recognition by the Government (Bhuiyan, 1988).

Since the early 1980s the Government of Bangladesh played an active role in improving the level of shrimp farming technology. Pond preparation, liming, fertilization, pest control, nursery production, supplementary feeding and water management have only started to be introduced during the last five years, and even now the technologies are not very much applied widely in the cultivation areas (Bhuiyan, 1988).

In the past two decades there has been a rapid growth in shrimp culture in Bangladesh. Production of cultured shrimp increased from 4,000 metric tons (t) in 1978 to about 49,000 mt in 1997. Total shrimp production in 2003-04 from coastal shrimp farms was estimated at 75,166 metric tons from about 203,000 ha area (DOF, 2005). At present about 1, 70,000 ha of coastal land are under shrimp cultivation in the country (Karim, 2005). Shrimp farming

takes place in the districts of Satkhira, Khulna, Bagerhat, Barisal, Patuakhali, Bhola, Chittagong and Cox's Bazar.

Greater Khulna area comes out as the prominent *Penaeus monodon* farming area. It is situated in the coastal area, near Sundarbans which offering suitable conditions for shrimp cultivation. In Khulna District alone, an area of 60,000 ha land is utilized for shrimp culture which comprises 33% of the total farming area of Bangladesh.

Shrimp farming has been developed mainly within the polders created by the Bangladesh Water Development Board (BWDB) in low-lying coastal flood plains. Often these activities have been started without the consent of the BWDB, and one of the major concerns has been the creation of unauthorized sluice gates or channels through the perimeter dykes of the polders. Only those areas that are low enough to permit inundation of the land by at least 0.5 m of water at spring tides have generally been used for shrimp farming (Bhuiyan, 1988). These areas / ponds besides the tidal rivers are traditionally called gher that are alternately used for cultivation of rice and shrimp (Islam, *et al.*, 2005)

The elevation of the pond bottom is considered suitable if it enables draining of the pond almost any day of the year and filling it with water to the desired depth within a few days. Inability to drain and to fill the gher with water except during new and full moon is mainly due to high pond bottom elevation or due to narrow tidal fluctuations in areas far from the principal river mouths. This situation has often prevents maintaining the desired water depths (1.0 to 1.2 m) and quality of water in the *Bagda* farms. The water management in *Bagda* ponds is made more difficult due to inadequate width, depth of the canal at the point of the gates and on controls of openings the gates (Siriwardena, 1997).

Water exchange regimes - Many farms that practice traditional and improved extensive method of culture do not exchange water frequently. They exchange water fortnightly, i.e. on full-moon and new-moon days. The farmers do not know or do not make any attempt to estimate the percentage of water that they change at a time, indicating a lack of knowledge on water management.

In some areas (in Bagerhat District) farmers employ zero water exchange strategy, since there is no way for water intake and discharge without crossing the neighboring farmer's pond (Siriwardena, 1997).

In the bagda farms a frequent change of water is needed to maintain the water quality. The process also helps to introduce new food organisms into the pond and stimulate molting of shrimp. In stagnant water, decomposition of accumulated organic wastes or depletion of trace metals may affect shrimp growth.

Coastal shrimp (*Penaeus monodon*) aquaculture in Bangladesh is mostly practiced in a special type of field/pond situated by the side of a river called a Gher that is used to cultivate rice in winter and shrimp in summer. These are the site specific problems that are encountered during actual construction or after the construction of the *Bagda* farm. The following site specific and engineering defects have led to problems relating to production and health management in extensive and improved extensive *Bagda* farming systems. Improper pond bottom elevation leading is to difficulties in proper water management. Improper water control gates, low saline water turnover into complete fresh water during rains causing lethal stress (Islam *et al.*, 2005).

Many *Bagda* farms are situated in low saline areas. During rains these areas go completely fresh. Such fresh water conditions are unfavorable for *Bagda* farming. Thus the combination of acidic condition, low oxygen and fresh water condition causes stress in *Bagda* creating an environment for disease outbreaks during the rainy season. Correcting such site specific and engineering problems needs major engineering modifications at high cost. Therefore pond management practices have to be improved to minimize the detrimental effects of such site specific and engineering faults (Islam *et al.*, 2005).

Poor site selection for shrimp farm construction is one of the most common causes of reduced production over a period of time. Most of the problems, including poor growth, low survival or mass mortality have been shown to be associated with deteriorating environmental conditions both within the ponds and in the external environment. In many cases the main problems encountered by farms come with the incoming water (Pornlerd, 1996).

Intensive marine shrimp farming without proper planning and management has resulted in several problems such as water pollution, destruction of mangrove forest and conflicts of land and water resource among various user groups. Frequent change of pond water is needed to maintain water quality. The process also helps to introduce new food organisms into the pond and stimulate molting of shrimp. In stagnant water, decomposition of accumulated organic wastes or depletion of trace metals may affect shrimp growth (Kanokporn, 1997).

Oregon State University of Honduras conducts a research program on Water Exchange Volume on Water Quality and Shrimp Production at 1998. And this experiment is designed

to increase understanding of how pond dynamics and pond nutrient discharge in effluents are affected by water exchange. Development of best management practices Water exchange in shrimp ponds is probably practiced universally regardless of management system. In semi-intensive culture, water is exchanged primarily to correct low early morning oxygen concentrations. It is also thought to discharge metabolites which hinder shrimp growth. The benefit of water exchange has been poorly demonstrated. Some studies cast doubt on the need for water exchange in shrimp farming when aeration is used (Hopkins, 1993; Hopkins, 1994). However, semi-intensive shrimp farming in Central America uses no aeration and is firmly based on water exchange, usually on a daily basis (Teichert-Coddington, 1995).

The study was conducted in three areas of Khulna district namely, Paikgacha, Dumuria, and Dacop Upazillas. The rivers Shalta, Teligati and Shibsa are flown beside the three study areas Kapilmuni in Paikgacha, Shobna in Dumuria, and Tildanga in Dacop respectively. The Nasirpur Khal, Katakhali Khal and Kakra Bunia khal were the main Khal from where water was supplied in the areas respectively. The areas of the blocks were 3,821, 460 and 245 acre in Paikgacha, Dumuria and Dacop Upazilla respectively. The total number of farms were 1504, 304 and 99 and the total numbers of farmers were 1524, 350 and 468 in the three areas respectively.

Primary data were collected by several visits in the areas. Individual interview of the farmers, FGD (Focus Group Discussions) with the farmers and key informants interviews were performed for the purpose. The secondary data were collected from different sources such

as Central library of Khulna University, Seminar library of FMRT Discipline and Internet browsing.

There were farmers' associations in two of the three areas studied. The associations did not work, primarily because of interest of the power group's connection in the association, whereas the role of farmers' association in mitigating the problem of all sorts in the culture is crucially important. The association in the areas has to take the lead role in finding solution in the areas; the main Khal has to be freed from any obstacle for easy passage of water, there has to have ideal situation of water exchange for all the farms in an area under a planned and designed program of culture; saline water should not be taken all the way up to the area where canal/creeks reach with even meager supply of water. The present study has allowed having an inside into the problems.

1.2 Problem Statement

Management of water in the culture farms is one the principal problems of shrimp culture in the greater Khulna areas. Problem of water quality management arises from the uneven pond bottom, heterogeneous pond depths, inappropriate tidal flux at the mouth of the sluice gates, lack of supply of proper water, lack of chance of water exhange in suitable duration and social conflict among the stackholder farmers of a specific farming community in an area. There are other problems of water management in shrimp farms as well. The water canal is often leased out to the powerful ones in the area. They exercise control on the canal and the farmers in the area are completely dependent on the mercy and sweet will of the lessees. As a result the farms are affected by lack of proper water supply. All these factors are almost common and prevail in the farming areas and thus water quality management, has, in recent

time, come out as one of the most critical issues for successful shrimp culture in the coastal areas. The above problems relating to water use hamper the shrimp growth and production in the area drastically.

1.3 Hypothesis Setting

Lack of proper water management in the shrimp culture farms has come out as a serious problem for successful shrimp culture in Bangladesh. The issues of good management of water in the farms are many and varied. It is expected that with the study the issues will be clearly understood and mitigation measures will be suggested thereby helping to develop the practice of water management and production of shrimp in the farms.

1.4 Objectives of the study

In the shrimp farms, there are many water management crises. To detect the problems of water management in shrimp farms in Khulna region, the present study was conducted as case studies in three sites of Khulna district. The study assessed and reviewed the current situation of shrimp farming practices, in general, tried to understand the issues and problem with management of water in the shrimp farms, in particular. However, the study was based on the following objectives:

- To know the present situation of water management in the shrimp farms in Khulna region.
- To identify the critical issues deterring suitable water management in the farms.
- To suggest for improvement in the management of water in the farms.

Chapter Two

Literature Review

Chapter 2

Literature Review

A number of studies have been done on different aspects of shrimp culture in different parts of the world. Although considerable number of literatures dealing with water management in shrimp farms is available, but very little information was available in the area of water management. In the present study, attempts have been made to collect a few important references pertinent to the present study. Research works dealing with the influince of water management in the shrimp farms for good production have been published from different parts of the world and some of them were reviewed as follows.

Honculada (1997) mentioned that farmed shrimp contributed 27% of total world shrimp production in 1995 with a volume of 712, 000 tons. Undoubtedly, the shrimp culture industry earns valuable foreign exchange for developing countries and generates jobs across the industry from fry gatherers to growers and processors.

Flaherty *et al.* (2000) said that primary factor has been the establishment of low salinity for black tiger shrimp (*Penaeus monodon*) farms in areas much further inland from the coast than once thought feasible. The rapid development of low salinity culture in freshwater areas that are predominantly used for paddy rice cultivation, however, now represents a major land and water management challenge. After 1992, however, the shrimp culture industry world wide has been plagued with problems of environmental pollution and degradation, resulting in poor production and mass mortality due to diseases.

Water exchange in the shrimp farms was hardly possible these days, however, Karim (1986) has reported that during 80's about 30-40% of water in the ponds was use to exchange over 3-5 days during each spring tide cycle. From November to February, water exchange was a problem, the tidal amplitude being characteristically low in the region.

Angell (1994) on his Promotion of small-scale shrimp and prawn hatcheries in India and Bangladesh mentions that the tiger shrimp, *Penaeus monodon*, predominates in Asian shrimp culture production because of its fast growth and adaptability to the pond environment and artificial feed. Thailand's output of cultured shrimp rose from 110 mt in 1985 to 150,000 mt in 1992. Indonesian production has grown similarly, from 12,000 mt in 1985 to 130,000 mt in 1992. India's estimated farmed output in 1992-93 season was 47,000 mt, while Bangladesh produced 19,500 mt. Productivity remains low in these two countries. Although about 150,000 ha are devoted to shrimp culture in Bangladesh, the yield is only about 200 kg/ha. However, as good culture sites become scarcer, the trend towards intensification will accelerate. In India, with 70,700 ha in production, productivity is 665 kg/ha. Thai shrimp farmers produce average 2500 kg/ha.

Hambrey and Lin (1996) express that extensive aquaculture have been practiced for many years in Thailand. Conditions are ideal there with 2,700 km of coastline, much of which is sheltered, warm and calm seas and with abundant natural seed. Originally dykes were built around rice fields, sluice gates installed, and wild shrimp seed entered the fields and were retained. Production was mainly of *Penaeus merguensis* in the dry season and *Metapenaeus* spp in the wet season. In the 70s growing demand stimulated the use of supplementary feeds

and a move to semi-intensive production. In the south of Thailand at the present time there are no rules regarding water exchange. If disease is widespread then water exchange is reduced to a minimum; if pond water quality becomes poor and does not respond to treatment, water is exchanged.

Oregon State University of USA conducts a research program on Water Exchange Volume on Water Quality and Shrimp Production in 1998. And this experiment was designed to increase understanding of how pond dynamics and pond nutrient discharge in effluents are affected by water exchange. Development of best management practices that minimize potential detrimental environmental impacts must be approached through systematic evaluation. Water exchange in shrimp ponds is probably practiced universally regardless of management system. In semi-intensive culture, water is exchanged primarily to correct low early morning oxygen concentrations. It is also thought to discharge metabolites which hinder shrimp growth. The benefit of water exchange has been poorly demonstrated. Some studies cast doubt on the need for water exchange in shrimp farming when aeration is used (Hopkins, 1993; Hopkins, 1994).

However, semi-intensive shrimp farming in Central America uses no aeration and is firmly based on water exchange, usually on a daily basis (Teichert-Coddington, 1995). On the other hand, preliminary evidence from past experiments indicates that water exchange could be reduced without impact on shrimp production. Excessive water exchange wastes fuel, contributes to deterioration of pumps and sedimentation of water supply canals and ponds, and may increase total nutrient discharge from ponds.

Vu Dung *et al* (2005) said in a report on fluctuation of some environmental factors in tiger shrimp culture ponds of low water exchange system in Hai Phong, Vietnam that low water exchange system for shrimp culture developed by the Marine Fisheries Research Institute is presently a culture model that is widely applied in the coastal provinces of the North of Vietnam. However, the management of culture ponds is an urgent problem in the system. To study fluctuations of some environment factors in shrimp culture ponds as basis of environment control measures is necessary for development of sustainable shrimp culture.

Pornlerd (1996) conducted research on low water exchange systems for shrimp culture and found that poor site selection for shrimp farm construction is one of the most common causes of reduced production over a period of time. Most of the problems, including poor growth, low survival or mass mortality have been shown to be associated with deteriorating environmental conditions both within the ponds and in the external environment. In many cases the main problems encountered in the farms come with the incoming water. Sites with sea water of less than 20 ppt benefit from this system since the evaporation can raise the salinity during the summer. In areas where the salinity is above 30 ppt, reservoirs are required to dilute the salinity in the pond. Underground freshwater is also of benefit on this type of farm. A separate water treatment area is necessary, especially on farms without access to low salinity water or fresh water. Water needs to be free from viral carriers and should be low in sediment and organic matter.

Pornlerd (2003) reported that tiger shrimp (*P. monodon*) is able to survive and grow in wide range of salinity from 2 to 45 ppt. Therefore shrimp farmers can expand their farms extensively in different area/environment. However, extremely high or low salinity always

causes more problems than the suitable salinities which range from 15 to 25 ppt. Culture in extremely high salinities over 30 ppt may cause disease problems, particularly white spot or yellow head virus and luminescent bacteria. He further suggests points out problems of shrimp culture during the wet season. Many farmers have faced the problem of fluctuations in salinity and temperature causing various diseases that generally cause farmers to lose their crops. They have also had problems with stunted growth or black gill condition. Many of these problems, however, can be overcome. Most farmers generally prefer to stock shrimp in the wet season, as they believe there can be fewer problems than in the dry or cold seasons. He also suggests that culture in the wet season brings various problems as well.

Islam *et al.* (2005) report about certain site specific problems encountered during actual construction or after the construction of the *Bagda* farms. The site specific and engineering defects have led to problems relating to production and health management in extensive and improved extensive *Bagda* farming systems are improper pond bottom elevation leading to difficulties in proper water management, improper water control gates and low saline water turnover into complete fresh water during rains causing lethal stress. Many *Bagda* farms are situated in low saline areas. During rains these areas go into completely fresh condition. Such fresh water conditions are unfavorable for *Bagda* farming. Thus the combination of acidic condition, low oxygen and fresh water condition causes stress in *Bagda* creating an environment for disease outbreaks during the rainy season. Correcting such site specific and engineering problems needs major engineering modifications at high cost. Therefore pond management practices have to be improved to minimize the detrimental effects of such site specific and engineering faults.

The Marine Shrimp Culture Research Institute, Department of Fisheries in Thailand reports that Thailand marine shrimp culture industry has still encountered production and marketing problems. The production problems are caused by unsuitable culture area and individual shrimp farm zoning, culture problems and inappropriate farm management, inadequate quality shrimp species, low shrimp survival rate and shrimp disease spread, environmental impacts, low yield, chemical and antibiotic residues and high production cost.

Thailand has recently become the largest producer of black tiger prawn (*Penaeus monodon*). However, such intensive marine shrimp farming without proper planning and management has resulted in several problems such as water pollution, destruction of mangrove forest and conflicts of land and water resource among various user groups. He also said that frequent change of pond water is needed to maintain water quality. The process also helps to introduce new food organisms into the pond and stimulating molting of shrimp. In stagnant water, decomposition of accumulated organic wastes or depletion of trace metals may affect shrimp growth. He also indicated about the occurrence of set interrelated problems as an outcome of over expansion of the shrimp farms in the limited land and water resources making the practices unsustainable and which needed an urgent address and remedy. As such land-use policy and planning should take a more holistic approach, taking into account the interest of all resource users, especially the poor, instead of focusing on only a particular sector (Kanokporn, 1997). Water management is a key intervention in solving the conflicts between agriculture and fishery production.

With regard to prevention and health management in coastal shrimp culture, Siriwardena (1997) in said that seasonality in culture, including cold and warm months and the vast river delta of Bangladesh provides an opportunity for diversification of shrimp culture. There is a lack of technical knowledge in the management of shrimp farming and increasingly more areas are being developed into shrimp farms without proper scientific assessment. It has been claimed that the Bangladesh shrimp farming industry has suffered severe problems in the recent past due to disease outbreaks, mainly SEMBV. According to the Department of Fisheries (DOF), Bangladesh suffered a 44.3% production loss in 1996, leading to a reduction in foreign income of 42.3% from exporting cultured shrimp from the coastal farms. Therefore there is an urgent need to address the production related problems in the present shrimp farming industry in Bangladesh. He also said that water exchange regimes that many farms practice are traditional; the improved extensive method of culture does not exchange water frequently. They exchange water fortnightly, i.e. on full-moon and new-moons. The farmers do not know or do not make any attempt to estimate the percentage of water that they should change at a time, indicating a lack of knowledge on water management. In many areas farmers do not exchange water at all, since there is no way for water intake and discharge without crossing the neighboring farmer's pond.

Traditional and improved extensive farmers do not measure any water quality parameter. By their experience farmer arrive at the idea that salinity decrease in June/July months because of excessive rain leading the salinity close to freshwater until it starts rising from October.

Chapter Three

Materials and Methods

Chapter 3

Materials and Methods

3.1 Selection of study area

The study areas were selected from three sites (Site 1, 2 and 3). The Site 1 was selected from Kapilmuni Union of Paikgacha Upazila, Site 2 from Shobna Union of Dumuria Upazila and Site 3 from Tildanga Union of Dacop Upazila (Figures 1.showing the Upazilas).The areas were chosen on the basis of availability of shrimp farms, channel(s) distributing water and accessibility in the area, in general. The villages covered in the respective site were Taltala, Nasirpur, Kashimnagar and Ramnagar in Site 1; Badurgacha in Site 2 and Kakrabunia in Site 3. The principal rivers supplying water in the areas were Shalta, Teligati and Shibsa in site 1, 2 and 3 respectively. The main channel and sub-channel(s) supplying water in shrimp farms besides, in the three sites were Nasirpur Khal, Katakhali Khal, Kakrabunia Khal (Figures 2, 3 and 4). The data on water management issues were collected by visit and Questionnaire Survey, Focus Group Discussion (FGD) and Key Informants Interview in the areas.

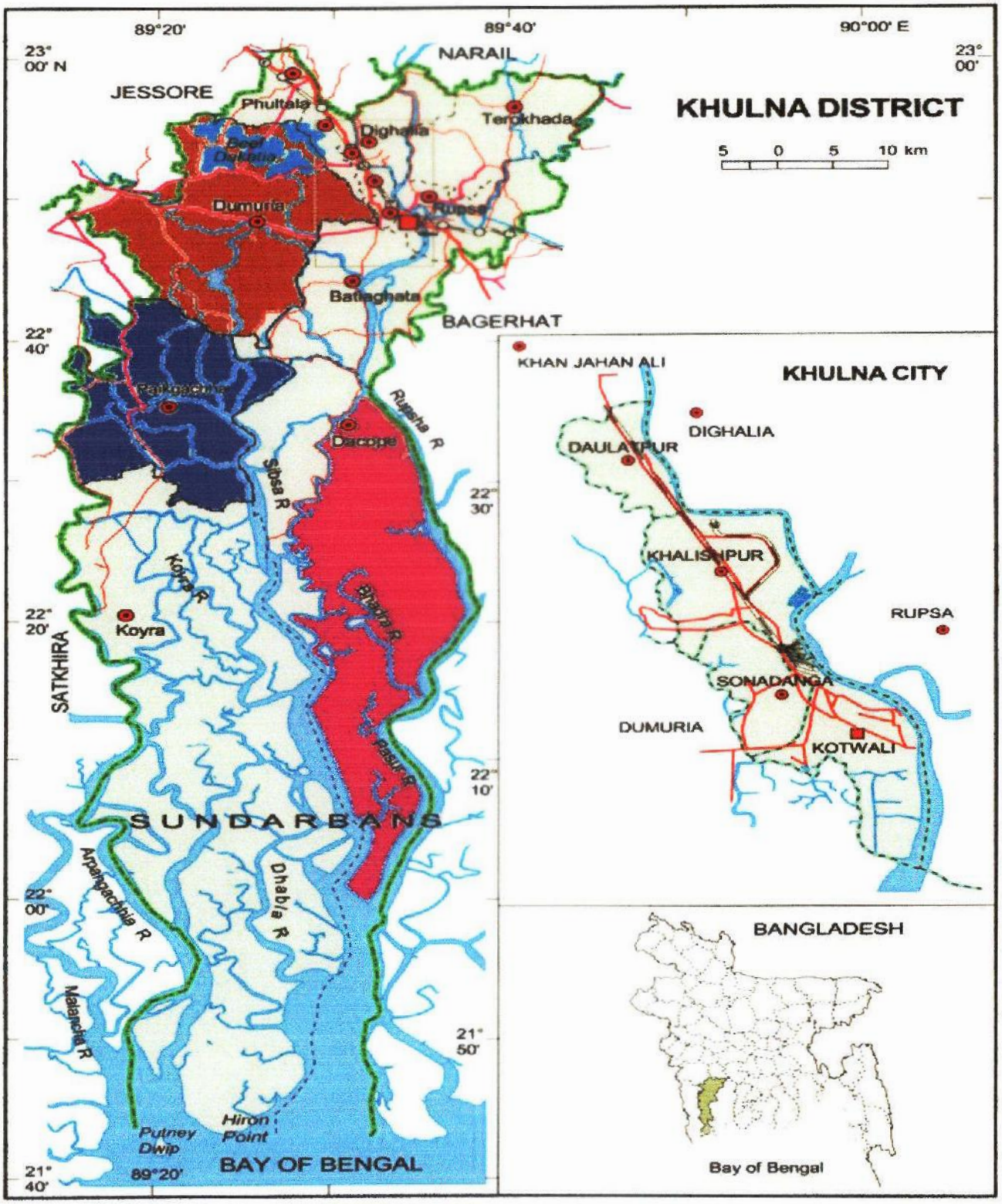

Figure 1. Political map of Khulna district showing three areas of study

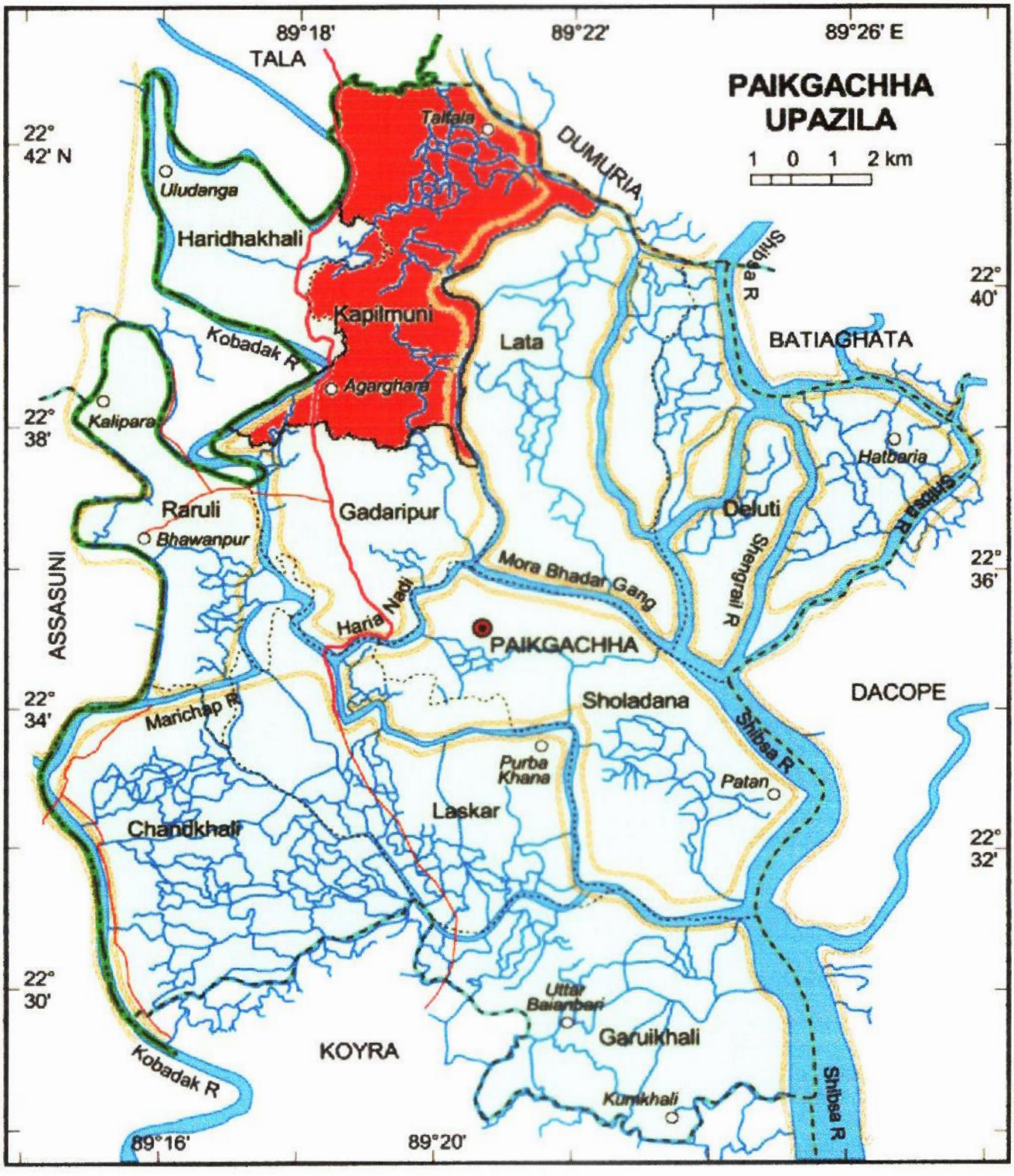

Figure 2. Political map of Paikgacha Upazila showing the study site 1 in red color

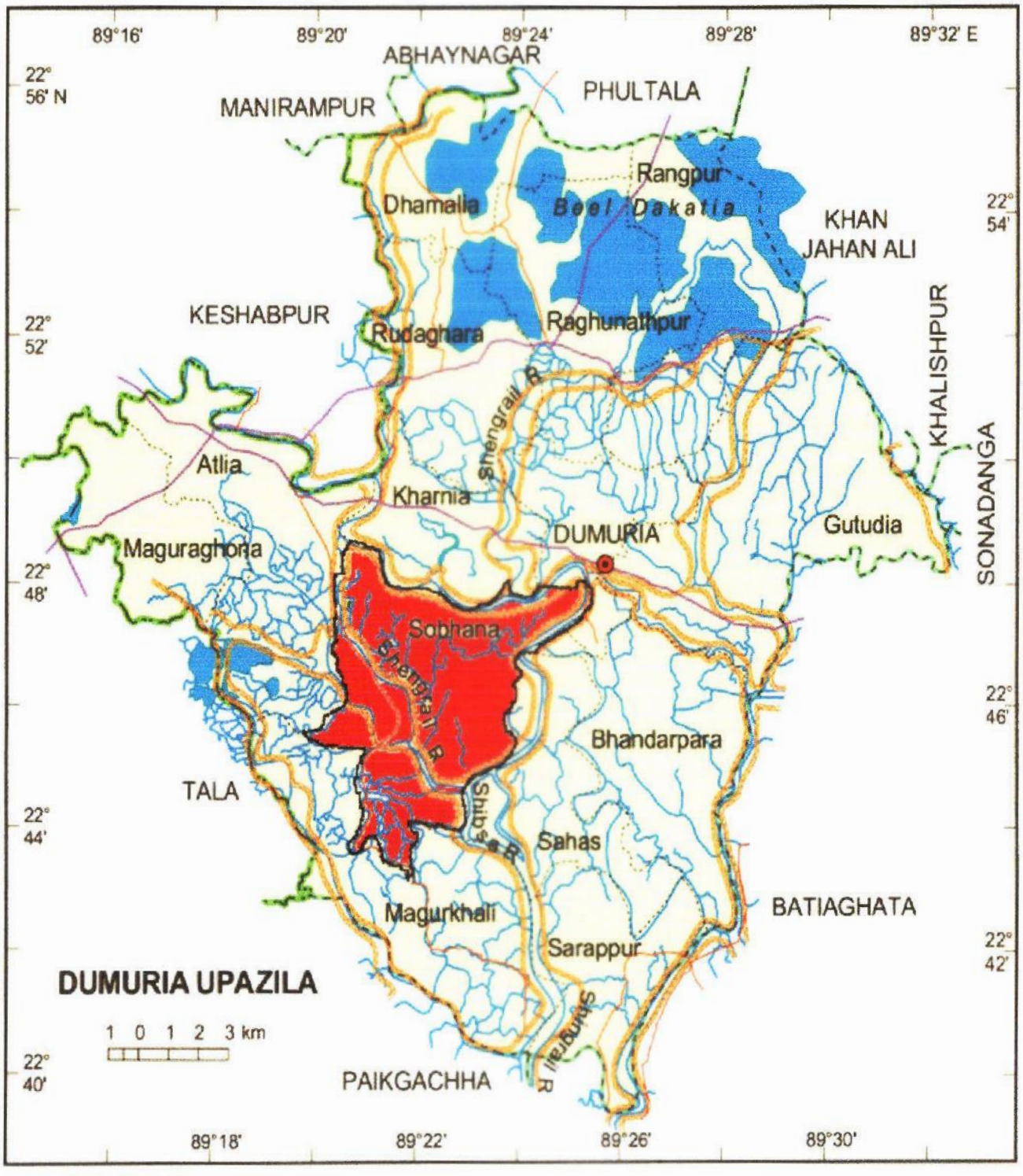

Figure 3. Political map of Dumuria Upazila showing the study site 2 in red color

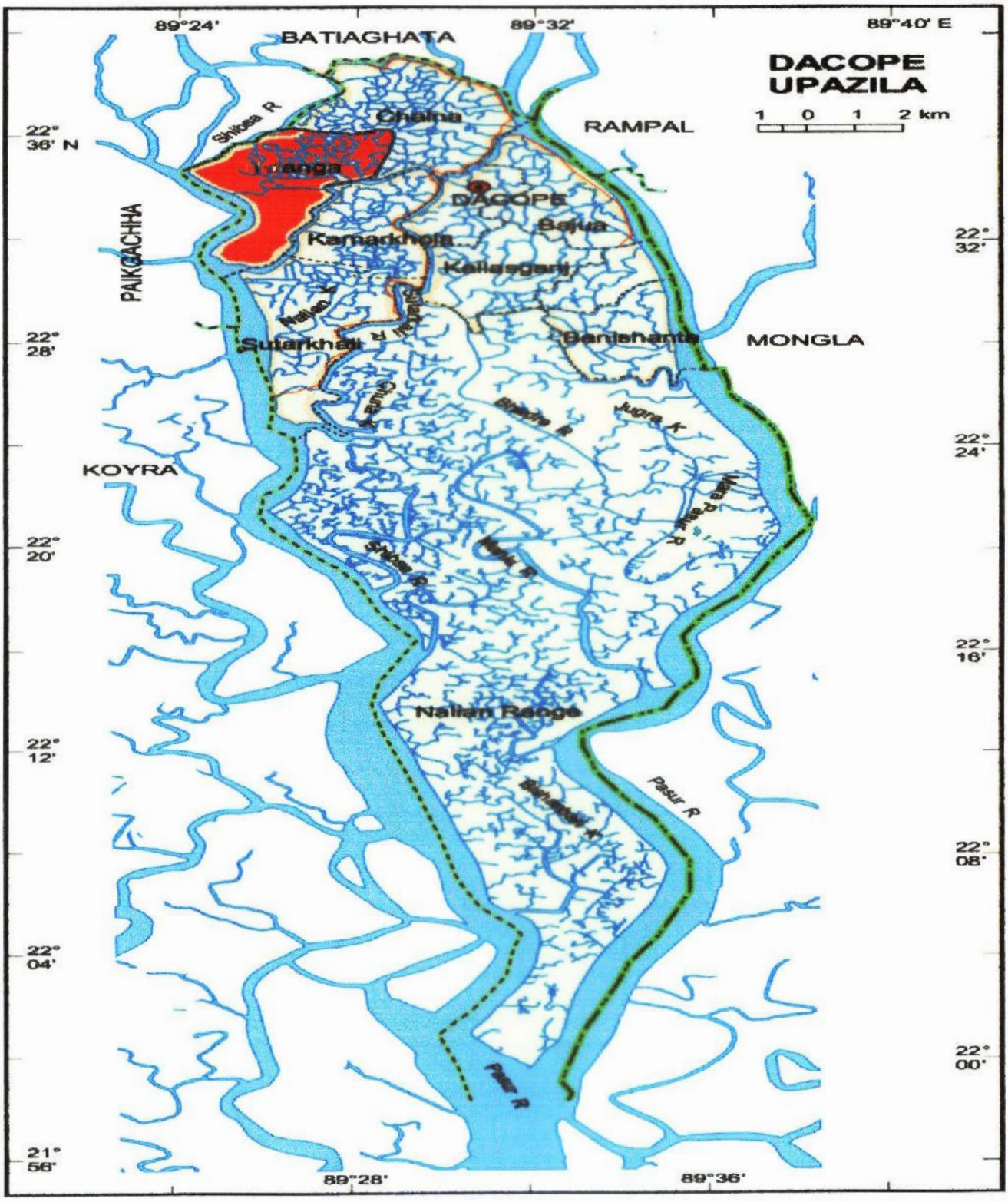

Figure 4. Political map of Dacop Upazila showing the study site 3 in red color

3.2 Questionnaire preparation

Efforts were made to develop a suitable questionnaire that could help to bring out the clear picture of the present situation of water management in shrimp farms which is often said as the principal problem of shrimp culture in the areas. For this purpose reconnaissance surveys were made in all the three sites before the start of the work. The questions were specific and were free from any kind of bias.

3.3 Data collection

3.3.1. Primary data

For primary data collection several visits were made in the study areas. A total of 30 farmers were interviewed from each of the three areas and 10 other people like, school teacher, Imam, ward member, social leader, village doctor etc. from each of the area were interviewed as key informants. One FGD with an average of 12 farmers was conducted from each area. The information on total number and area of farms taking water from the main Khal, channels and sub channels supplying water from main Khal, maximum distance of farms from main Khal, number of farms across taking water from the Khal, depth of water maintained in the farms, the present condition of the Khal, tidal height in the Khal, condition of dike of the main Khal, water exchange situation in the area, arrangement of opening of the sluice gate, mechanism of solution of water-use problem in the area, existence of farmers' association etc. were collected.

3.3.2 Secondary data

The secondary data were collected from the following sources such as from Central library of Khulna University, Seminar library of FMRT Discipline and from Internet browsing.

Chapter Four

Results

Chapter 4

Results

4.1 Case study

Site 1

The site 1 was in Kapilmuni Union of Paikgacha Uupazila. The villages falling in the site were Taltala, Nasirpur, Kashimpur and Ramnagar. The site was situated beside the river Salta in Polder number 16, getting water through Nasirpur Gate being connected with the Nasirpur Khal.

Number of farmers, farms and their area

The total area of the block was 3,821 acre; the total number of farm and farmer in the block were 1504 and 1524 respectively. There were 3 sub-canals in the block. The supply situation was that the main Khal supplied water to 623 farms while the number of farms supplied by water from the sub-canal 1, 2 and 3 were 400, 312 and 173 respectively.

Distance of supplying water

Distance to which water was supplied from the Khal varied from 0.5 to 2 km. The sub canals supplied water to far distances. The maximum average distance supplying water from the main khal and the sub-canals were 2 km and 1.29 km respectively in the block.

Farms taking water over other farms

The number of farms over water was taken was more than the number of farms taking water directly from the main canal. It was found that 440 farms took water directly from the khal and 1114 farms took water indirectly from other farms in the area.

Present status of the Khal

The length of Nasirpur Khal is 6.22 km with an average width of 32 meters; the total area of the Khal is about 20 ha. The Khal was taken lease by the Chairman, Kapilmuni Union from the Government a few years ago for fish farming. The shrimp farmers of the area were under the conditions that they could take water in their farms in time of their needs but in reality, the lessee used to open the gate only when he required water for his purpose in the Khal. There were arrangement for payment of money at specified rate for taking water from the khals, however, the farmers did not want to disclose it in the interview. During rainy season when there was excess water and needed letting the water out the farmer had to depend on the sweet will of the lessee. So the hard reality was that the farmers in the block could not let water in or out according to their need and time. The lease arrangement did not only affect shrimp cultivation in the dry months in letting water in or out from the farms in time of needs; during rainy season when aman cultivation started and when some shrimp farms were yet to be finally harvested, often there were serious problem of water logging. The lessee did not open the gate for letting the excess water out from the farms and / or from the agricultural lands for which there were flooding that swept away shrimp crop, damaged paddy fields and other vegetations in the area as a whole.

Water depth in Khal

During high tide the depth of water in the fore end of the Khal remained on an average at 21.45 ft and in the far end of the Khal depth was obtained on an average at 11.34 ft. Siltation was a serious problem in the Khal and the depth of water was sharply reduced in the area starting about half a kilometer away from the sluice gate; the depth was obtained from that area at about 9 ft.

Hindrance in the flow of water

The flow of water in the Khal was seriously impeded because of erection of enclosures for the purpose of shrimp culture in the Khal by the lessee; bamboo *Patta* and net were used for partitioning the Khal. During the time of letting water in, the flow of water in the Khal got increasingly reduced at the far end of the Khal, resulting less availability of water for the farms located in that part of the Khal. The effect of the barriers could easily be reckoned by the difference of the levels of water on either side of the Patta; there was 8-9 inches difference in the water level between the fore end and lee end. The barriers aggravated the situation at the time of water exchange and during rainy season particularly. Because it took longer time for passage of water through the barriers; in times of expelling excess water due to rain, often temporary flooding occurred in the block during rainy season. Exchange of water for the same reason, became difficult creating problems for effective management of water in shrimp farms. There were 9 *Patta*/net partitions in the Khal. The species that were cultured in the Khal were Bagda, poultry, etc.

Height of the embankment

Height of the embankment was not satisfactory. It is found that the embankment beside the Khal was constructed by farm owners who had farms in adjacent to the canal. If they did not make it strong then their cultured shrimp and fish were easily escaped. So the farmers make the embankment more or less good for their benefit. In some areas where there were no farms adjacent condition embankment was very poor and in that often flooding occurred. As a result water could not be taken at higher level suitable to create more pressure for letting water easily in the farms located at various distances from the inlet gate.

Water inlet and outlet canal

There was no separate inlet and outlet for letting water in and out from the individual farm.

Depth range of the farms

The depth of water in the farms varied from 1 to 3 ft in this area. The farms which were away from the main Khal had comparatively lower depth than the ones which were located near to the main Khal, however, the maximum and minimum average depths of the farms in the area were found to be 2.43 and 1ft.

Exchange of water

Periodical exchange of water of shrimp farms is an important consideration for ideal management of the farm but there was no facility of exchange of water in the farms. The farms took water through a common inlet used for several farms in the area; often water was taken over other farms. However, though taking water over other farms was possible with

comparatively easily, letting water out over other farms was not that easy. Thus many farms could not exchange water and completed the culture cycle with water that was taken once at the time of stocking. There were 1114 farms in the area that could not change water because of this difficulty.

Pollution

There were four poultry farms beside the Khal; there was incidence of disposal of wastes particularly the household wastes in the main Khal. Also, there were many hanging latrines on the Khal. These sources of waste could potentially undermine the quality of water of the Khal for use in shrimp farming, any way.

Organization

Formation of Associations/Societies with the shrimp farmers in the farming areas was thought of as a means of getting rid of many of the prevailing problems with shrimp farming. The villagers of Ramnagar mentioned about the existence of a committee in the village. The Chairman of Kapilmuni Union Council was the President of the Committee; however, it was reported by the villagers that because the Chairman himself was the lessee of the Khal, the committee utterly failed in finding solution of the problems of water management in the area.

Sluice gate

There were 5 windows in sluice gate for water control. The labor employed by the lessee opened and closed the sluice gate. The duration of opening was not fixed; however, it was about every after 15 days or more. Hitherto has been mentioned about the bad impacts of the

lack of coordination in the opening of the sluice gate in the shrimp farms. Not only are there serious impacts of timely available facility for exchange of good quality water in the shrimp farms; a lack of coordination in the opening and closing of the sluice gate created a havoc in the areas during rainy season; the same farms are transformed into paddy fields after shrimp harvest and in the absence of arrangement for timely opening of the sluice gate, any heavy down pour creates flooding within polder sweeping away the crops and vegetation.

History of the shrimp farming in the area

History of shrimp farming in the area was not very old. According to some inhabitants shrimp culture in the area was first started since 1970. It was known that, one called Harun Gazi had first started shrimp culture in the area in the year 1989 and since then the practice got through. Shrimp culture used to be done in the area by rotation with aman cultivation like in majority of other areas of the region, however, for the last few years it became a round the year activity; water from the farms was not fully drained because of drainage congestion in the mouth of the river; the farms are now rotated for bagda and galda culture in the dry and rainy seasons respectively.

Important water management problems in the area

- The farmers could not let water in or out at their need because they were dependent upon the wish of the lessee of the Khal.
- Only the farmers having farms beside the Khal could exchange water but they also depended with the coincidence of the time when the gate was opened for the lessee's purpose. Farmers having farms in the interior could not exchange and had to depend

on the previous adjacent farms, over which water was taken; if the lessee dewater only then a farmer could exchange water coinciding with their time and will.

- Often the interrelationship among the farmers in an area was not smooth and did not let water pass over their farms.
- The lessee of the Khal used *Patta*, net etc for fish culture in the Khal. These hindrances seriously affected water flow in the Khal encouraging heavy siltation in the mouth of the canal.
- Many small sub-canals in the area were closed and water supply in the distant farms was seriously hindered; the farms could not let out their water at all.
- The disease pathogens and virus could be dispersed through water from one farm to another and thus the farmers did not want let water from others' farm passing through their farms.
- The farms situated at the last end of the Khal did not get water because of siltation and lack increased pressure of water in the Khal.
- Often the lessee did not let water flow fast so that it made damaged the fence and net enclosure allowing fishes and shrimp escape from the pen.
- The wastes from the poultry farms and domestic wastes polluted the water making it unsuitable for shrimp culture.

4.2 Case study

Site 2

The site 2 was located in Shobna Union of Dumuria Upazila. Only one village – Badurgacha was selected from this site. The river supplying water in the site was Teligati and the sluice gate was called Bhakotmari built over Katakhali Khal. The length of the Khal was 1.5 km and the average width was 4 meters; the area of the Khal was found to be about 6 ha

Number of farmers, farms and their area

The area of the block was 460 acre. The number of farmers and farms in the block were 350 and 304 respectively. The Katakhali Khal supplies water in the block through two sub-canals. The sub-canal 1 supplies water in 112 farms while the sub-canal 2 supplies water to 192 farms.

Distance supplying water

The distance to which water is supplied varied from 0.25 km to 1.25 km. The maximum average distance was found to be 1.08 km from the sub-canals.

Farms taking water over other farms

The number of farms over water was taken had been more than number of farms taking water directly. 95 farms took water directly from the Khal when 215 farms took water indirectly from the Khal.

Present status of the Khal

The length of the Khal was 1.5 km and the width was 4 m. The area of the Khal was 6 ha. A villager of Badurgacha had taken lease of the Khal a few years ago for fish culture and wild fishing. The condition of water use with the lessee was that the shrimp farmers around the Khal could take water from the Khal only when the lessee would open the sluice gate for water for his own requirement. The farmers of that area could not let water in or out in time of their need. They had to depend on the lessee of the canal.

Water depth in Khal

The depth of water in the fore end of the Khal during high tide was on an average at 11.40 ft; in the last end the depth was obtained on an average at 4.89 ft. The depth of the Khal was about 7.6 ft on an average. There was far difference of water depth between the two locations. This difference was created because of heavy siltation, slow water flow due to hindrances, narrow width of the Khal etc. The depth was not homogeneous all over the Khal. The depth was more in area adjacent to the gate and after that it was decreased creating less flow and heavy siltation. In the last end of the Khal the depth was less than in the fore end of the canal.

Hindrance in the flow of water

Bamboo *Patta* and net were used in the Khal for fish culture in the Khal. These barriers hindered the flow of water and by the time the water reached to last end of the Khal there was no flow at all. The impact of the hindrances could be easily reckoned from the difference of the water levels on two sides of the Patta; the level was higher at the fore end and the difference was about 6-7 inches. There were 4 *Pattas* and nets in the Khal. The farmers

having farms at the last end of the Khal did not get sufficient water; they could not exchange water either, in time of need. In the rainy season, after harvest of shrimp, there was excess rain and because the gate was not opened and flow of water was slow, flooding easily occurred in the block sweeping away the crops and vegetation. The *Patta* speeded up the siltation process in the Khal as well. Silt was gathered easily in the area before the *Patta* and as such the mouth of the Khal became shallow.

Height of the embankment

The height of the embankment was very low; it was 8.42ft on as average. The construction of the embankment was not done well. The embankment of the Khal was mainly constructed by owners of farms beside the canal. Because the embankment was not built at proper height, during high tide when water was let in the main Khal, there were damages to the embankment and farms besides were affected; whereas to create more pressure of water in the main Khal for easily taking water to far distance, increase of height of the embankment was imperative.

Water inlet and outlet canal

There was no arrangement for separate inlet and outlet canal in the block; there being only a common inlet canal for all the farms in series and water was taken over several farms when needed.

Depth range of the farms

Depth of water in the shrimp farms in the block varied from 0.5 ft to 5 ft. The maximum and minimum average depths were found to be 3.8 and 1 ft.

Exchange of water

There was no facility of exchanging water in the study areas. They only took water in one inlet and had no other outlet which could be used as letting water out from the gher. The farmers were fully dependent on the previous farms for taking water in or letting water out.

Pollution

There was incidence of disposal of wastes, particularly the household wastes in the main Khal.

Organization

There was not any committee/association for the farmers in the area.

Sluice gate

The sluice gate had 3 windows in that block. The gate was maintained by the lessee. A labor employed by the lessee opened and closed the gate in time of need by the lessee; the gate was opened for the purpose of letting water in for fish culture in the Khal and the duration of such opening, as obvious, was not fixed and was estimated to be every after 15 days or more. Because there was no fixed schedule of opening of the gate, the necessity of the farmers were not given due consideration. The situation got serious turn during rainy season when excess rain water used to rise up and needed to be let out and because of closure of the gate, there were flooding in the area with consequent loss of rice production in the block. The gate, however, was opened ultimately with the request of the people in the area but that was too late to save the losses.

History of the shrimp farming in the area

Shrimp culture was started in the area in 1970. During the liberation war the ghers were destroyed and shrimp culture then was stopped. After that in 1974 it was started again. The farm size was bigger in the initial days and most of the ghers were managed under share cropping basis. Now a day the culture is primarily based on leasing system and the farm size has been reduced and managed by single owner; the average size of shrimp farms was found to be 1.5 acre.

Important water management problems in the area

- The farmer could not let in or out water from the gher in time of their need and they had to depend upon the consideration of the lessee.
- Water supply was highly unsatisfactory in the farms because of reduced water flow in the far end of the Khal and for this reason the farms in the last end get less water.
- The farmers just beside the main Khal could only exchange water when the lessee of the canal would exchange water in the Khal for his own purpose.
- The lessee of the Khal used *Patta*, net and other barriers for fish culture in the Khal. The hindrances seriously impeded water flow and encouraged siltation in the Khal.
- The interrelationship between the farmers was a matter in water supply in the block; so exchange of water over others' farms was not possible.
- The disease pathogen and virus of one farm could contaminate others, if water exchange was done over other farms so the farmers often did not agree to let water out over their farms.

- During letting water in the farms the flow of water in the Khal was needed to increase and the lessee did not let water to flow swiftly otherwise the *Patta* and net barriers would be damaged and fish and shrimp would escape from the enclosure.

4.3 Case study

Site 3

The site 3 was selected from Kakrabunia village, under Tildanga Union of Dacop Upazila. The area was within the Polder number 31. The sluice gate was built over Kakrabunia Khal. The site is situated beside the river Shibsa.

Number of farmers, farms and their area

The total area of the block was 271.76 acre. The total number of farmers and farms in the block was 468 and 101 respectively. The average area of the farms was 2.69 acre. There was no sub-canal for supplying water in the area.

Distance supplying water

The Khal supplied water to various distances farms from 0.75 km to 2 km. The maximum average distance was 1.72 km.

Farms taking water over other farms

The number of farms over water was taken was more than the number of farms taking water directly from the Khal. It was found that 31 farms took water directly from the khal where 70 took water indirectly over the other farms from the khal.

Present status of the Khal

The total length of the main khal was 1.6 Kilometer and the average width was 7.6 meter. Area of the khal was about 1.2 ha. The Kakrabunia Khal was not leased out to any body. The

Khal was free for the public use. They used the Khal as water sources and fishing area. The poor and landless fisherman could fish there freely. There were *Patta* and net enclosures erected by the landless farmers for fishing in. The Khal was already heavily silted and as a result of that it became narrow in width and the flow of water at the far end of the Khal was highly reduced. The farms lying just beside the Khal got water easily, however, the farms lying far away did not get water easily. These far distant farms took water over other farms and could not let water out because of a reported social conflict among the farmers in the area. The farmers often took water from other farms with money or by exchanging fish.

Water depth in Khal

The water depth in the khal at high tide in the fore end was 14.38 ft and at the last end of the khal was 7 ft. The average depth of the khal was about 10.15 ft. The depth was not equal at all the points of the Khal. The water depth of the khal near the gate was higher but after some distances there was heavy siltation in the khal and so the depth decreased rapidly at that point. Water depth in the last point of the khal was less than the fore end.

Hindrance in the flow of water

There were some barriers, *Patta* and net in the Khal. These barriers were put by the landless people for catching fish in the Khal and as obvious, the water flow in the Khal was impeded highly and farms at the far end did not get proper flow at all. For this reason water depth in the last end was very low. There were 2-3 inches differences in water level between two sides of the *Patta* and net barriers. There were 3 *Pattas* and net barriers in the khal.

Height of the embankment

Height of the embankment was not in good condition. The average height of the embankment was 12.5 ft. At places it was found that during high tide, entering water was flown over the embankment. The water was spread out in nearby farms or other places near the gate. The water in the Khal reduces its pressure. The slow speed of water was also hindered by other barriers. So the water did not reach at same water throughout the Khal. The farms at the last end got less amount of water. The sufficient amount of water was very essential for shrimp culture. To maintain the water level in the khal as well as in the farms; maintenance of the height of the embankment was necessary.

Water inlet and outlet canal

There were no separate inlet and outlet canals to exchange water in the study area. The shrimp farms had only inlets. The farms that were adjacent to the main Khal only took water from the Khal but those were far from the Khal they took water from the previous farms.

Depth range of the farms

The water depth of the farms varied from 1.5 to 5 feet in area. The maximum and minimum average water depths were 4 ft and 2 ft in the farms.

Exchange of water

Water exchange is very much important for shrimp culture. Exchanging water controls dissolved oxygen levels into water and salinity levels in the water. Water exchange allows the farms to get good quality water and that enhances molting of shrimp and increases

growth with consequent higher shrimp production. There was no facility of exchanging water in the farms. The nearby farms could get water directly through one inlet and rest of the farms that were not attached to the Khal not did get water directly. There were 31 farms adjacent to the Khal and 70 farms were away from the Khal. They got water through other farms. These farms could take water but had no chance for letting water out for exchanging. The farmers of this area were fully depended on the nearby farms for taking water. Some farmers had no idea about water exchanging for shrimp culture.

Pollution

There was incidence of disposal of household wastes into the Khal. There are three hanging latrines on the khal. These latrines and household wastes create potential risk in water quality for use in the shrimp farms.

Organization

There was a committee of the farmers in the study area for water management and improvement of shrimp culture. This committee was meant for welfare of the farmers however, it did not work in finding solution of the water management problems in the area.

Sluice gate

A labor employed by the committee used to open and close the sluice gate. The labor is paid by the committee. Generally he opened the gate at the farmers' requirement. The gate had two windows for passing water. He was supposed to open the gate any time to meet the needs of the farmers in the block. This opening and closing systems sometimes made problems.

There was arrangement for maintenance of the opening and closing of the gate however, the management often did not work properly. All the farmers were the members of the committee but had little say on the control of the gate. Persons related with the management committee often had taken the responsibility of gate management. Some times the gate was opened and closed for the purpose of the management committee itself. The gate also used to be controlled by the farmers who had large farms.

History of the shrimp farming in this area

Some people said that shrimp culture in the area had started first in 1980. In the initial stage the farm size was large; owners of different land sizes together use to make a single farm with arrangement of sharing of the cost and benefit which was called 'Gonogher' at that time. After that with the advent of improvement in the technology and higher price of shrimp in the foreign market shrimp culture under Gonogher and share cropping concept had been changed in the area and now it is done mainly individually. Since 1992 shrimp culture was being done alternately with transplanted aman rice in the area, as else where in the region. Until recent time shrimp cultivation used to be a seasonal venture but now it was almost perennial in the area because water from the farm land was not dried or drained completely because of siltation in the mouth/canal supplying water. The cultivation of rice is being hampered for the same reason in the area as well.

Important problems of water use

- The farmers did not agreed to give water to others because of low water depth in their farms

- The disease pathogen and virus of a farm could contaminate the farms when water was passed through, so the farmers nearby did not agree to let water in through their farms. The case was often other way round; a farmer of a well managed farm did not want to take water through other farms on the fear that his farm might be contaminated.
- The paddy culture was hampered seriously for heavy water in the farms so the farmers lost their interest for paddy culture.
- The farmers did not get water at their requirement for shrimp culture.
- The landless fisherman used *Patta* and net and other hindrances for fishing. These hindrances affect the water flow of the canal and also encourage heavy siltation in the canal.
- Sometimes the sluice gate was controlled by rich persons who had bigger farms there and also they were the controller of managing committee.
- The water of the river did not reach the last end of the Khal and for this reason at the last end the farms did not get enough water for good shrimp culture.
- Sometimes interrelationship among the farmers was not good, and then they did not agree to supply water from their own farms to the nearby farms.
- The distant farms had not separate inlet and outlet canal for water exchange.
- The farmers did not want to supply water to the nearby farms because during water passing through dike, the fence and net of the mouth of partition would be lose and the fish and shrimp would escape.
- The latrines and the household wastes made the water unsaved for shrimp culture.

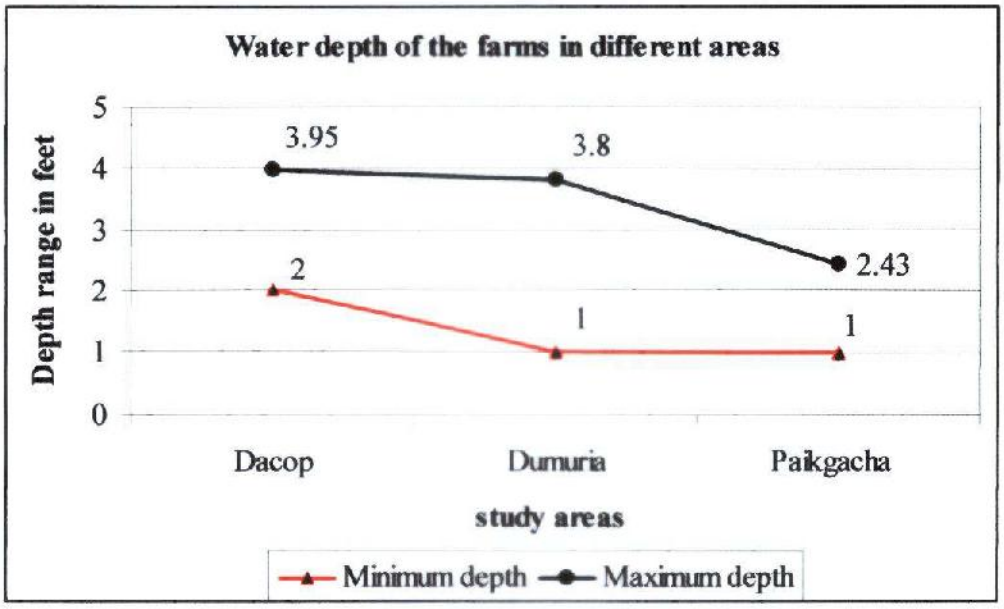

Figure 6. Comparative water depth of the farms in the three different areas.

Distance of water taken

The distances the main Khals supplied water were 0.5 km to 2 km in Paikgacha, 0.75 km to 2 km in Dacop and 0.25 km to 1.25 km in Dumuria, however there were sub canals in the Kapilmuni and Dumuria sites and the distances the water from the sub canals were supplied were 1.29 km and 1.08km. It was not easy to maintain water management properly by distributing water to so far distances. The maximum distance to which water was taken from the main Khal in three different areas is given below.

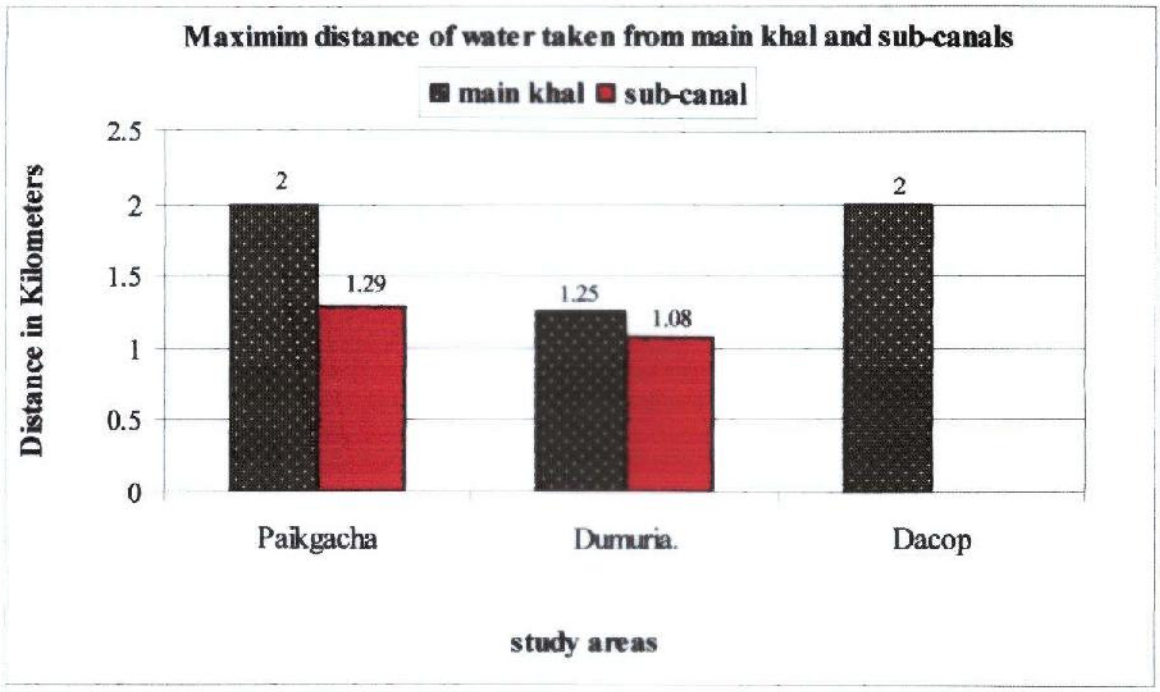

Figure 7. Comparative maximum distance of water taken from khal in the three different areas.

Chapter Five
Discussion

Chapter 5

Discussion

Bagda shrimp culture had started within the BWDB's polders in the coastal areas of greater Khulna and Satkhira areas adjoining the Sundarbans forest and within the polders of the Chakaria Sundarbans areas of Cox's Bazar. The polders were built in 1960s to protect the coastal lands from intrusion of saline water for the purpose of cultivation of rice. The practice did run for a few years however, since early 1980s the farmers in the area started to let saline water in the lands during winter months for entrapping the brackish water shrimp PL coming with the high tide. There were BWDB approved sluice gates built on the rivers/Khals passing over the polders for passage of excess water out from the polder in time of need. However, with the increase of price of tiger shrimp in the international market the practice of culture got a rapid pace over the last two to three decades and farmers in the areas variously cut the embankment illegally and placed wooden sluice gate for taking saline water into their farm for shrimp culture. This created a legal problem with Water Development Board (Embankment Act-52) and social conflict between shrimp farmer and agriculture farmers. To resolve the conflict the government of Bangladesh adopted administrative measures in 1986 by issuing administrative order to regulate shrimp farming in a manner which would not affect the interest of others and shrimp farming could only be allowed in such area where more than 85% of land owners have consent for shrimp farming and that shrimp farming would not affect the adjacent rice field through leaching saline water. The embankment could not be cut to take saline water into shrimp farm without proper permission of the BWDB. The local government (*Upazila Parisad*) along with concerned government official was responsible to execute the policy order. To give incentive to fisheries sector, the government

declared aquaculture and hatchery as industry for which they would get tax holiday, reduced rate of bank interest etc. The government executive order of the cabinet division for management and regulation of shrimp culture was up dated and revised in 1998.

Under different development projects (shrimp culture project, Third Fisheries Project), government developed water management infrastructure for shrimp farming and as World Bank loan agreement condition in 1992, the government imposed taxes (shrimp culture Tax-1992) to the shrimp farmers who were benefited by BWDB water management/development program as cost recovery but rate of realization of the cost was very poor.

Now a day Bagda shrimp has assumed an extremely important position in the export market earning a huge sum of foreign currency for the country. The technology of culture could not keep pace with the demand of the product; per unit production of shrimp has remained ever low in the farms, thus instead of a vertical extension in the technology, there has been a huge horizontal expansion in the acreage of the farms in the coastal areas, in general. There are many problems with the culture venture that is going on; however, the expert opinion goes that, among all the different problems that can be mentioned for successful shrimp culture in the region, planned water management is probably the single most important one.

The size of the farms used to be enormously big with multiple owners with the system of share cropping, however, of late, there is the tendency for making the farm smaller with single ownership or at best with a few owners, but consequent with the higher demand of shrimp and sub optimal rate of production, the farming areas has had increased exceedingly

in the areas and now the situation is that farming area has been stretched up to the distance where any meager amount of water flow is available from the nearby creek/Khal. The end result is that water quality management in the farms is very poor; production is low and disease out breaks becomes inevitable; the White Spot Syndrome Virus (WSSV) was first occurred in the areas in late 1980s and since then it has become a recurrent phenomenon in the farms. The poor water management is, hitherto, always blamed for out break of the virus disease.

The problems of water management in the area were discussed in relation to the practical situations and for that three representative areas were chosen in the form of case studies. The three areas were Kapilmuni Union of Paikgacha Upazila, Sobna Union of Dumuria and Tildanga Union of Dacop Upazila. The areas chosen were representatives of the regions supplied with water from rivers of different natural conditions; if the coastal area of the greater Khulna and Satkhira is considered from the East to the West, it is seen that the rivers in the Western side have all been under very severe threats of siltation with high rate of reduction in the flow of water. The shrimp farming activities consequently is getting difficult in the west because of lack of availability of good quality water. The situation is still relatively better in the Easter areas because of availability of better water flow in the rivers in the areas. The farms in the respective areas were located beside a main Khal from which water was taken in the farms. There were clear differences with respect to the chance of availability of getting good quality water in the farms in the areas. The number of farms, average size of the farms and the maximum and minimum distance to which water was carried to and number of farms across water was taken over, lease arrangement of the main

Khal, existence of any association of the farmers in the area etc were looked for and discussed.

In Kapilmuni area, the sluice gate was built over Nasirpur Khal and water was taken through two sub canals and a maximum distance of 13 km was covered through sub-canals. The problem of siltation in the river there was more acute. The maximum number of farms across water was taken over was 489 in the area; the maximum numbers of farms across water was taken in Sobna, Dumuria and Tildanga, Dacop were 90 and 31 respectively. The number of farm and farmer were much higher, 1504 and 1,524 respectively in Nasirpur area; in Tildanga, Dacop and Sobna, Dumuria the numbers were 101 & 468 and 304 & 350 respectively. The total areas of farms in the three areas were 3,821, 272 and 460 acres with average sizes of the farms being 2.54, 2.69 and 1.5 acres respectively. There were reports that complete drainage of water from the farms of Kapilmuni area was not possible in the recent year turning the land under water logged throughout the year. Rice cultivation in the farms thus has been problematic.

The main Khals supplying water in the farms were variously affected. The intriguing fact was that the Khals were leased out to powerful local member of the community. The lease holders maintained the sluice gates. Although there were agreement that the gates will be opened for taking water in or letting water out in time of need of the farmers, but in reality that did not happen. For ideal management of water from the main supplying Khal and to help resolving the conflict arising out from water use, it has always been suggested for formation of farmers' association in the farming areas, but that also did not work. Out of the

three areas studied, there were committees in two areas – Kapilmuni, Paikgacha and Tildanga, Dacop. In Sobna, Dumuria, there was no committee. In all the three areas, the problems of water management were all the same. The UP Chairman himself was the Chairman of the committee of Kapilmuni area and he did not play a due role to let the committee function. There were irregularities in opening and closing of the gate; the farmers within did not get water in time of their need; there were problems both during culture season and also during rainy season. In Dumuria site, again, the lease holder of the Khal did not comply with the verbal agreement on supplying water to the farms in time of need. There was no committee of the farmers for dealing with the issues of water use in the area. The Kakrabunia Khal at Dacop, though, was not leased out, but had been left free for use of water by the local community and for fishing by the poor and landless fishermen; the management of the sluice gate was erratic. The responsibility for opening and closing of the gate was though rested on the farmers' association in the area; however, the arrangement did not work; the committee did not function in maintaining the arrangement either. A few powerful ones got control of the committee and schedule of operation of the gate was maintained according to their need and requirement and not with respect to the general need of the farmers within the block. The Khal was affected in the same way as did in other areas, by erection of *Patta* and net enclosures by the landless farmers, reducing the flow of water in the Khal seriously. The farms at the far end did not get the desired pressure of water to easily let water in the farm. Siltation was an inherent problem in the Khals in all the sites. The depths of water in the fore end of the Khals were more but in the far end it was always smaller due to siltation. The average depths of the Khals were 11.34ft, 7.6ft and 10.15 ft in Nasirpur Khal, Katakhali Khal and Kakrabunia Khal respectively.

The quality of water of the Khals was observed to be affected by sources of pollution like dumping of domestic wastes, constructing hanging latrines and poultry sheds over the Khals. In Katakhali Khal, Kapilmuni, there were four poultry farms near and several hanging latrines over it; hanging latrines were also there in the Kakrabunia Khal at Dacop. Use of such water can not be advisable for good aquaculture practice for shrimp culture, anyway.

Water used in the farms has to be of highest quality for achieving good aquaculture practice of shrimp. The farming water gets degraded in quality and thus required to be exchanged with fresh intake from the main source; the system in Bangladesh does not have the chance of exchange of water, no matter how much deterioration of quality takes place, however, from environmental perspective of the farming area as a whole, the discharged water should be of equal quality to the intake water and there should be no significant impact of effluents from farms on surrounding ecosystems or other aquaculture operations. Discharged waste water must not exceed the assimilative capacity of receiving waters. Adequate measures should be taken to minimize the outflow of nutrients and / or natural waters. The pollution of surrounding waters or land from excessive discharge of organic and inorganic wastes should be prohibited. Release of toxic or otherwise harmful substances (including diseased shrimp) in the ponds, channels or banks must not be permitted. Where any potentially toxic or bio accumulative chemicals have been used, waters should not be discharged until compounds have naturally decomposed to non-toxic form. At the hatcheries, farms and in the processing plants, similarly, the sanitary facilities for disposal of human wastes should be provided with utmost stringent consideration. The septic runoff from humans and animals must be excluded from shrimp ponds for better hygiene and health (Environmental Justice Foundation, 2003)

Hitherto has been mentioned about the extreme horizontal expansion of the shrimp farms in the area. The farming area has been extended up to about 12 kilometers in the areas of study concerned. The main Khals, though, supply water to the farms nearby; water was taken to far distance through sub-canals. There were no separate inlets or outlets for taking water in or letting water out. Water was taken over other farms from the fore end of the supply. To prevent the deterioration of the pond environment, pond water should be continuously freshened by the entry of new water from the river or from other water source with removal of old water through separate outlet canal (Elvira, 1989). To effect flow-through water management and to facilitate water exchange through supply and drainage canals, NACA (1986) suggested for separate inlet and outlet canals in shrimp ponds. ASEAN/SCSP (1978) suggested the following advantages of having separate inlet and outlet canal in the shrimp farm complex. These are: (i) better filling and non-contamination of pond by discharge from other ponds; (ii) greatly reduced possibility of spread of disease; iii) maintenance of constant head in intake canal thus reducing water loss through leaks/seepages in pond dikes and consequently reducing leaching of acids into the ponds from dikes with acid-sulphate soils; (iv) absence of conflict of usage between farmers; (v) better water exchange for individual ponds, and (vi) possibility of effecting flow-through systems. The inlet and outlet gates should be located at the opposite corners of the same pond. The ASEAN/SCSP also suggests that the water conveyance structures – the separate inlet and outlet system not only allow smooth water management in the farm, the system also provides the facility for holding and harvesting of fish; the waterway system serves the means for transporting farm supplies.

Such a system is highly demanding in water management in Bangladesh shrimp farms also, but the same is a question of remote future. The picture in Bangladesh context is alarming,

any way. At present it was seen that often water was taken over many farms across. The maximum number of farms over which water was taken in the three areas was averaged at 206. Taking water over several owners' farms was seriously limiting in the process of practice in water management. The pressure of water in the main Khal was not high enough for taking water to far distance over several farms. Again, whatever pressure was obtained, it was obviously felt higher at the initial few farms and letting water out over to the next farms, could potentially damage the gates and the screens of the farms resulting unexpected escape of shrimp crop. Also, such an arrangement of water use needed existence of congenial terms among the farm owners but often such relation did not prevail, creating problems in water use.

The principal reason why the water pressure in the main Khal could not be raised was that the height of the embankment of the Khals was low thereby limiting filling the Khal with water at high level. Increasing the height of the embankment was the job on the part of the owners of the farms besides, but because the coordination among the farmers and between the lease holder and the farm owners did not work, the height of the dike could not be maintained at the desired level. Moreover, the farms laying immediately besides the Khal did get desired pressure for getting water easily; they did not bother for increasing dike height for extra higher pressure of water for letting water passage to other farms laying at the far distance.

The depth of water was highly heterogeneous in the farms; the depth range was found to vary from 0.5 ft to 5 ft. in the farms in the three areas. Elvira (1989) suggested for maintaining water depth at 1meter for optimal growth of shrimp. The farms are actually the agricultural

lands that are flooded with saline water for shrimp cultivation and often agricultural lands of multiple owners are used in a single farm/gher. It is obvious that all the lands in an area are not at the same level and thus when water is entered in the area; the depth in the gher becomes uneven, any way. Uneven depth in the farm brings about heterogeneity in the physico-chemical properties of the water and coupled with this condition when constraints arise from the lack of water exchange from the farm, the productivity situation in the farms becomes highly vulnerable. It is needless to mention that the unit production of shrimp from the farms in Bangladesh is highly less in comparison to the production obtained in many other countries of the world.

Chapter Six

Conclusion and Recommendation

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Conclusion and Recommendation

The south-west coastal region of Bangladesh is unique in several ways. It comprises the districts of Satkhira, Khulna, Bagerhat and the Southern part of Jessore. The region is basically a tidal wetland that gets flooded by high tide and is suitable for brackish water shrimp culture. The study was conducted in three separate regions in the area to assess the present situation of water management in the shrimp farms. The three areas were Kapilmuni of Paikgcha, Sobhna of Dumuria and Tildanga of Dacop Upazila. The main Khals were heavily silted; it occurred near the mouth of the khal and thus the depths of the khals were greatly reduced. The main Khals were leased out to local powerful non shrimp farmers. They controlled the sluice gates and the farmers did not get water at their necessity. The lessees also used patta/net as barriers for fish culture in the khal and erection of the structures reduced water passage rate in the khal. For this reason, water reached in less volume in the last end of the khal. The sluice gates were not operated for the purpose of welfare of the farming community. The lessees did not open the gate even when there were serious needs for letting excess water out during rainy season, causing flood. It also hampered the agricultural products. There had been some social inconvenience for getting water for shrimp culture over the farms. There were also pollution problems in the Khals. Dike height of the main Khal was not enough for taking water at higher level for increased pressure of water for taking water easily by the farms at distant position. There were no separate inlet and outlet canals except the farms lying just beside the main khals or sub canals. So the farms at far distance had no chance for exchanging water. There were associations of farmers in

Paikgacha and Dacop but the association / farmers committees were non functional. The farmers could not maintain the homogeneous water depth in the farms because of lack of proper water supply and consisting of uneven bottom of farms. Various types of shrimp diseases were broken out for lack of proper water management. Virus diseases were prevalent and being contaminated with water of other farms. Of the various problems of shrimp culture suitable water management could be termed as the principal one for improvement of shrimp culture significantly. The following could be recommended for improvement of water management in the shrimp farming ponds, in general.

- The shrimp farming has to be done in designated areas; it would not be done in any where and every where like what is being done now. So a suitable planning for zoning in shrimp farming is necessary.
- There has to have separate inlet and outlet canals for letting water in and out from the farms. The growth of shrimp depends upon moulting and since moulting is dependend upon suitable water quality, facilities for water exchange in the farms is a must.
- The khas khals would not be leased out any party.
- Water quality of the main khals has to be maintained preventing from possible sources of pollution.
- There has to have active and vibrant association of the farmers to deal with any issue regarding shrimp farming.
- All small sub-canals beside the main Khal have to be cleared off and freed

Chapter Seven
References

Chapter 7

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Appendix

Appendices

Questionnaire No. 1

Survey on the problem of water management in the shrimp farms in Khulna areas; Bangladesh

1. Name of the respondent:

2. Name of the location:

3. Name of the river / khal:

4. Number of farmers in the area:

5. Total number of farms and total area in the locality:

6. Number of sub channel supplying water in the locality:

7. Number and areas of farms around the sub channel/ Khal, if there is any in the locality

	Number of farms	Area of farm
Sub channel 1		
Sub channel 2		
Sub channel 3		
Sub channel 4		

8. Distance supplying water from each sub channel:

	Right side	Distance(m)	Left side	Distance(m)
Sub channel 1				
Sub channel 2				
Sub channel 3				
Sub channel 4				

9. Maximum distance of supplying water from main channel/sub channel:

10. Number of farms passed across for taking water in the farm:

a. Passed across 1 farm: Number
b. Passed across 2 farms: Number
c. Passed across 3 farms: Number
d. Passed across 4 farms: Number
e. Passed across 5 farms: Number
f. Passed across 6 farms: Number

11. Arrangement with the channel / khal lessee and farmers in taking water:

12. Are there any conditions for taking water from the khal?

13. If there are, what is the impact of such arrangement?

14. Is the canal given lease to others for farming or other activities?

15. Height of the tide (= water level) at the fore end and at the last end of the canal

16. Is there any hindrance in the flow of water in the canal/ khal? (Like patta in the cannal):

17. What is the impact of such hindrance on water management in the farms?

18. Present status of the canal/ khal:

Length:

Width:

Height of embankment:

Area of the khal: acre/bigha:

19. Average depth of the canal/ khal:

20. Number of farms having separate water inlet and outlet canals:

21. Depth range of the farms (approximate):

Maximum (m/ft):

Minimum (m/ft):

22. Highest and lowest temperature prevail in the farm:

23. Do the shrimp farmers exchange water?

If not, why?

24. Is there any factory beside the khal?

25. Is there any source of disposal of wastes such as poultry farms or household nearby the main khal?

26. Is there any latrine beside the khal?

27. Do the farmers have cooperative/ committee/ samity etc?

Organization of the association (Chairman, Members etc)

If there are, what do these associations do in case of water management?

28. Is the lessee of the canal included in the association?

29. Who open and close the sluice gate? When and the duration? Does it make any problems?

30. History of the shrimp farming in this area

31. List the important problems of water use

a)

b)

c)

d)

e)

f)

32. Suggestions/recommendations for solving the problems

1.

2.

3.

4.

5.

6.

Questionnaire No. 2

Key informants interview schedule on:

Survey on the problems of water management in the shrimp farms in Khulna areas, Bangladesh

1. Name and identity of the respondent:

2. Name of the location:

3. Name of the river / khal:

4. Number of farmers in the area:

5. Total number of farms and total area in the locality:

6. Number of sub channel supplying water in the locality:

7. Number and areas of farms around the sub channel/ Khal, if there is any in the locality

	Number of farms	Area of farm
Sub channel 1		
Sub channel 2		
Sub channel 3		
Sub channel 4		

8. Distance supplying water from each sub channel:

	Right side	Distance(m)	Left side	Distance(m)
Sub channel 1				
Sub channel 2				
Sub channel 3				
Sub channel 4				

9. Maximum distance of supplying water from main channel/sub channel:

10. Number of farms passed across for taking water in the farm:

a) Passed across 1 farm: Number
b) Passed across 2 farms: Number
c) Passed across 3 farms: Number
d) Passed across 4 farms: Number
e) Passed across 5 farms: Number
f) Passed across 6 farms: Number

11. Arrangement with the channel / khal lessee and farmers in taking water:

12. Are there any conditions for taking water from the khal?

13. If there are, what is the impact of such arrangement?

14. Is the canal given lease to others for farming or other activities?

15. Height of the tide (= water level) at the fore end and at the last end of the canal.

16. Is there any hindrance in the flow of water in the canal/ khal? (Like patta in the cannal):

17. What is the impact of such hindrance on water management in the farms?

18. Present status of the canal/ khal:

Length:

Width:

Height of embankment:

Area of the khal: acre/bigha:

19. Average depth of the canal/ khal,

20. Number of farms having separate water inlet and outlet canals:

21. Depth range of the farms (approximate):

Maximum(m/ft):

Minimum(m/ft):

21. Highest and lowest temperature prevail in the farm:

22. Do the shrimp farmers exchange water?

If not, why?

23. Is there any factory beside the khal?

24. Is there any source of disposal of wastes such as poultry farms or household nearby the main khal?

25. Is there any latrine beside the khal?

26. Do the farmers have cooperative/ committee/ samity etc?

Organization of the association (Chairman, Members etc):

If there are, what do these associations do in case of water management?

27. Is the lessee of the canal included in the association?

28. Who open and close the sluice gate? When and the duration? Does it make any problems?

29. History of the shrimp farming in this area

30. List the important problems of water us,

a.

b.

c.

d.

e.

Photo Gallery

Figures 8. The farms are taking water over the other farms

Figure 9. Use of patta and nets in the canal causing hindrances in water flow

Figure 9 is continued

Figure 9. Use of patta and nets in the canal causing hindrances in water flow

Figure 10. The farms are taking water from the main khal

Figure 11. The Poultry farms over the Khal