ENVIRONMENTAL ASPECTS OF SHRIMP CULTIVATION IN COASTAL BANGLADESH - A CASE STUDY IN COX'S BAZAR DISTRICT.

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A THESIS

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IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE DEGREE OF
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BY

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DHAKA.

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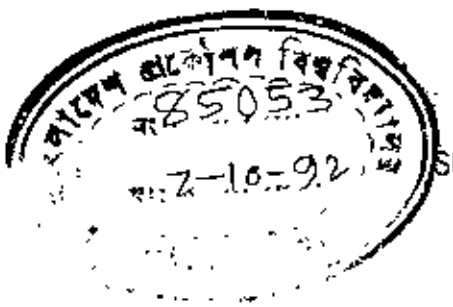

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ABSTRACT

Shrimp cultivation has become a significant agricultural activity in the south-west and south-east coastal areas of Bangladesh.Due to high international demand and high market price this has become a highly profitable business to the people of coastal region which increase the transformation of crop land to shrimp farm. But present practice of shrimp cultivation is extensive type and creates an ecological imbalance in coastal areas. Planning policies are therefore needed towards finding ways and means of achieving efficient utilization of land by which environmental degradation can be minimized and expected earning would not reduce.

The current research focuses on the present shrimp cultural pattern in three Thanas of Cox's Bazar district. The Study analyzes the effects and earns from three traditional pattern of shrimp cultivation and semi-intensive modern pattern of shrimp cultivation. Effects of shrimp cultivation are examined on vegetation, siltation and salinity.

The study identifies that Under utilization of shrimp farm due to lack of capital and know-how, yield low return but have a great extent of environmental negative impact which threat us that it may lead to decrease of fish in our river estuaries, decrease navigation facilities and even make land infertile and create crisis of fuel wood and animal food stuff.

The study suggests that development policies should be directed towards improving present shrimp farm from extensive to intensive type and impose restrictions to convert more agricultural land to shrimp farm. The study also recommends that Government's financial and technical support can make ensure farm gate price and decrease environmental pollution.

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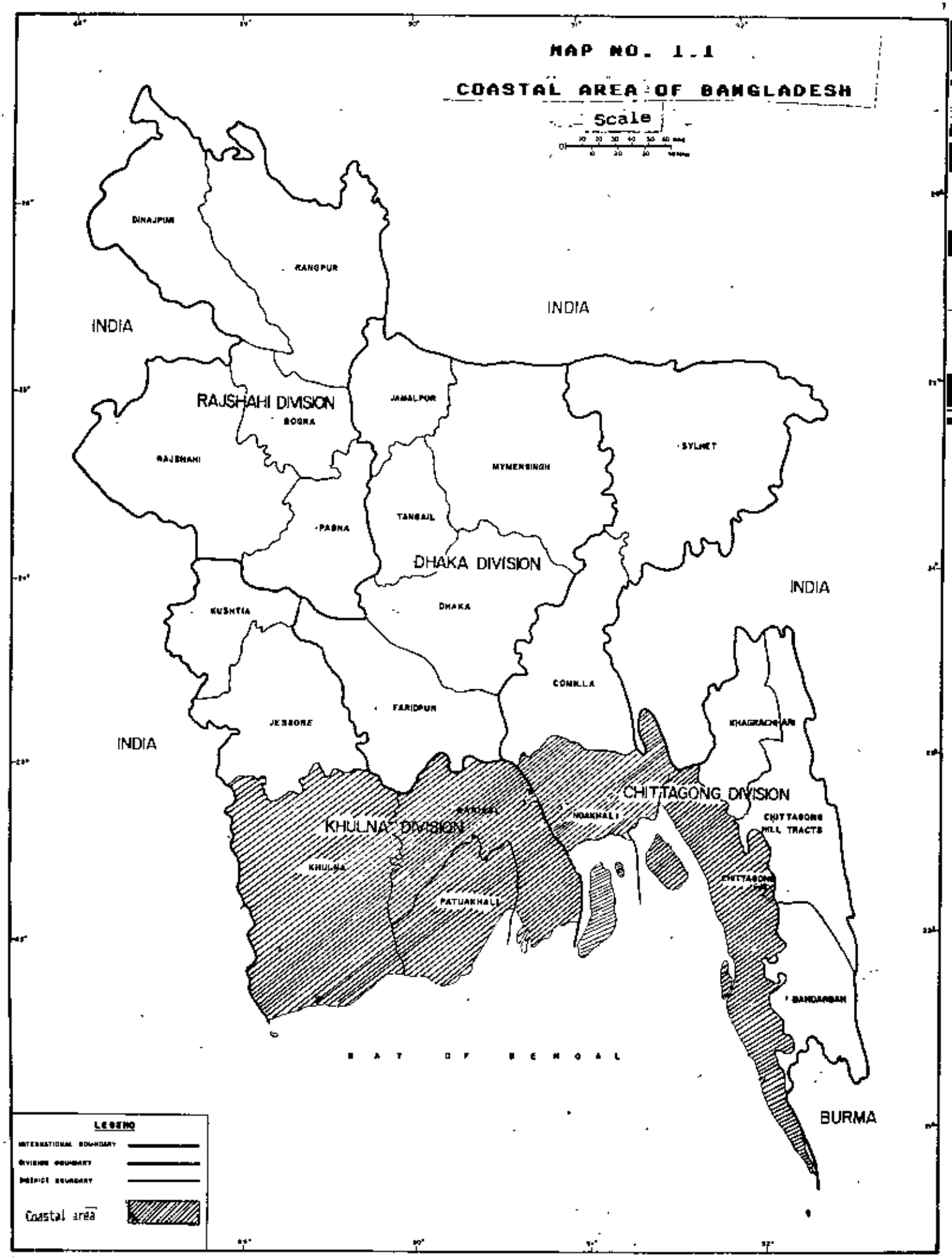

MAP NO. 1.1
COASTAL AREA OF BANGLADESH
Scale
DINAJPUR
RANGPUR
INDIA
INDIA
RAJSHAHI DIVISION
BOGRA
JAMALPUR
SYLHET
RAJSHAHI
MYMENSINGH
PABNA
TANGAIL
DHAKA DIVISION
INDIA
KUSHTIA
DHAKA
COMILLA
FARIDPUR
JESSORE
INDIA
KHAGRACHARI
CHITTAGONG DIVISION
BARISAL
NOAKHALI
KHULNA DIVISION
CHITTAGONG HILL TRACTS
KHULNA
PATUAKHALI
BANDARBAN
B A Y O F B E N G A L
BURMA
LEGEND
INTERNATIONAL BOUNDARY
DIVISION BOUNDARY
DISTRICT BOUNDARY
Coastal area

CHAPTER ONE

INTRODUCTION

1.1 General description of the coastal area of Bangladesh

There are approximately 25,000 sq. km. of coastal land in Bangladesh (FAO,1986). These land are suitable for brackish water aquaculture. This coastal land can be broadly divided into three distinct regions (Pramanik,1983); the eastern, central and western region. The eastern coastline of Bangladesh extends from the Big Feni River to Badar Mokam along Chittagong running parallel to young mountain ranges. The coast is regular and unbroken and is protected along the sea by mud flats and submerged sand. The smaller rivers of the eastern region also contribute to the active nature of the area. The central region runs from the Tatulia River to the Big Feni River estuary and includes the mouth of the Meghna River. This region is characterized by heavy sediment input, formation of char and bank erosion. And the western region covers the portion of Bangladesh coastline westward from the Tatulia river to the international boarder located at the Hariabhanga River. This is a stable region and is mostly covered with dense mangrove forests which lessen bank erosion.

Traditionally farmers have practiced an extensive form of fish and shrimp culture in the south western and south eastern coastal

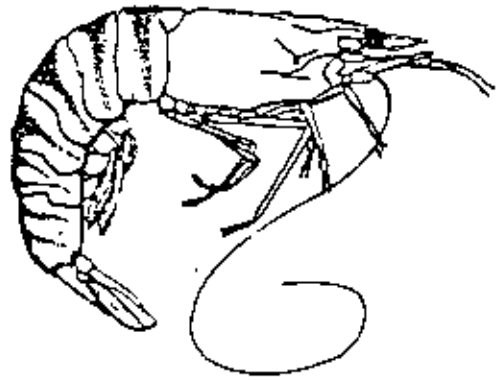
areas of the country. Now with strong international demand and high price (2 mounds of Jute or 1.5 mounds of paddy could purchased at a price worth only 1 Seer of shrimp), brackish water shrimp culture has become popular.

1.2 Contribution of shrimp in the economy of Bangladesh

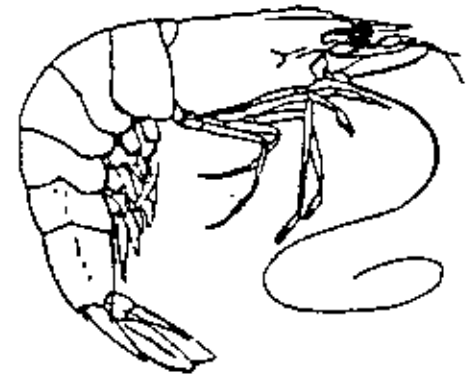
Shrimp cultivation on a commercial basis is a recent developed practice of Bangladesh. It is basically a exportable item which has grown rapidly due to high international demand. Frozen shrimp (i.e. shrimp tails) has become a major export item of Bangladesh. At present, the foreign exchange earning from shrimp export exceed the value of leather and leather product export which was traditionally the country's second most important export category after jute and jute products (World Bank, 1985). Table 1.1 shows the value of shrimp exported from Bangladesh from 1972/73 to 1979/90.

With the increasing contribution of shrimp in the economy of Bangladesh, the World Bank reviewed the fisheries sub-sector in 1983 and recommended to develop semi-saline shrimp culture in coastal areas to promote export earning. The Bangladesh Natherlands joint project team also addressed the export earning objective through shrimp culture (FAO, 1986).

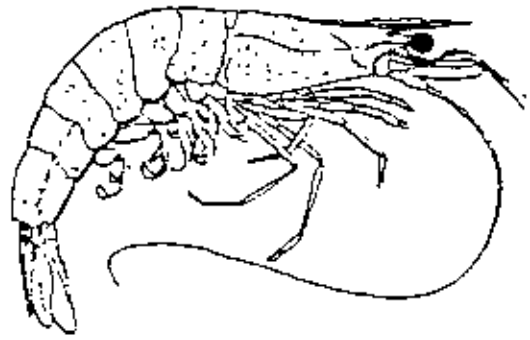
FIGURE 1.1 ; CULTURABLE SPECIES OF SHRIMPS



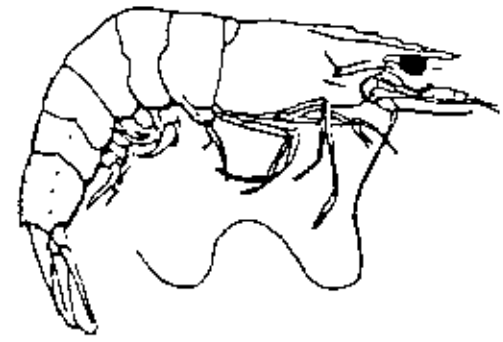
Penaeus monodon



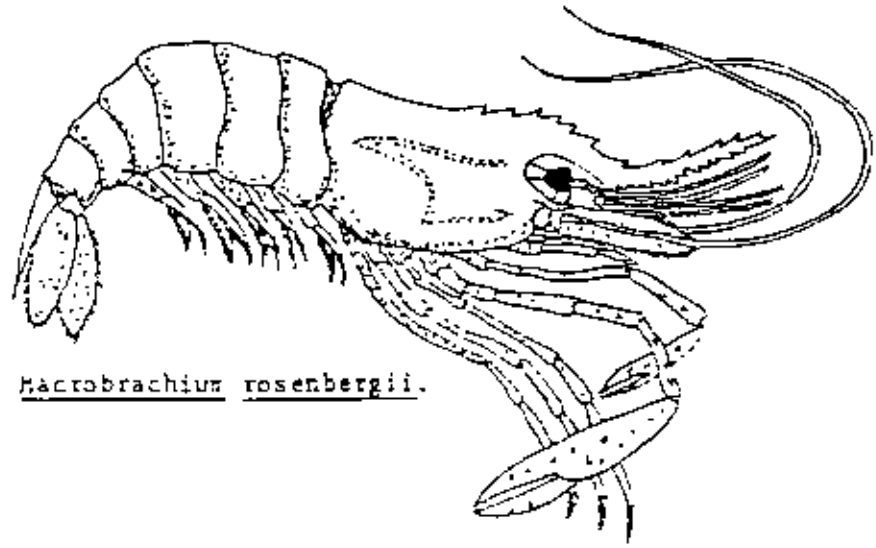
Penaeus indicus.



Metapenaeus monoceros.



Penaeus semisulcatus.



Macrobrachium rosenbergii.

Source : MPO, 1987, P. 2-16

Table -1.1
Value of shrimp exported from Bangladesh.

Fiscal year	Quantity (Metric Tons)	Value (Million of Taka)
1972/73	----	22.64
1973/74	2895	33.31
1974/75	1625	23.80
1975/76	2474	145.20
1976/77	3399	246.20
1977/78	2404	253.08
1978/79	4069	446.43
1979/80	5744	529.34
1980/81	6726	549.54
1981/82	8052	904.39
1982/83	11452	1499.36
1983/84	13751	1555.01
1984/85	15304	2054.10
1985/86	17448	2738.70
1986/87	16279	3418.00
1987/88	15027	3473.00
1988/89	15299	3820.00
1989/90	17541	4143.00

Source : Export promotion Bureau,Dhaka,Bangladesh, quoted in ESCAP, Bangkok,Thailand ,Ali. M.Y. p. 20.and BBS 1987, 1990.

1.3 Shrimp cultivation in Bangladesh

1.3.1 History

History of shrimp cultivation is very old in coastal Bangladesh. Farmers use to cultivate shrimp in small scale for a long time especially in Khulna region. But with strong international demand and high price. brackish water shrimp culture in the coastal areas has become popular very recently. Currently, brackish water shrimp aquaculture is practiced not only in the Khulna region in the south-west but also in the Cox's Bazar district in the south east. Such farming is also spreading to other districts of the coast.

Brakish water shrimp aquaculture in the Khulna region is rooted in the traditional Bangla bheri method. Tidal water is exchanged in low-lying depression or ghers embanked as farm areas. The ghers are connected to the tidal river or khal by making branches in Water Development Board embankments. Entry of water is controlled through box sluice placed across the sluice into a network of natural or artificial channels inside the *Gher*.

Although farmers have , in recent years , adopted a few innovation to improve their culture system, the present day practice does not differ significantly from the traditional extensive method of bheri culture. Under the present system, there is no way to segregate the shrimp post-larva from the juveniles of predator fish entering the ghers with tidal water or to control the member and species of shrimp that enter the farm. Hence , the yield is low when compared with achievable yield. This level of shrimp culture is termed "extensive culture" in the shrimp industry.

In the Khulna region, the cropping pattern is brackish water shrimp culture in the dry month followed by a crop of local variety of transplanted aman rice in the wet month from July-August to November-December on the same land inside the *gher*. In some areas, shrimps are grown as a single crop.

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* Bheri or Gher is an area impounded by earthen dyke with facilities for exchange of tidal water.

In Cox's Bazar district, brakish water shrimp/fish farming is done over large areas. Shrimp farming in Cox's Bazar is a post-independence phenomenon and started off in salt beds. Shrimp-cum-salt bed extend from Banskhali Thana in the present Chittagong district in the north to Teknaf Thana in the present Cox's Bazer district in the south. Now, they are concentrated in Kutubdia and Maheskhali Thanas. Crude salt is produced using solar energy from December to April and most of these salt beds are used to grow shrimp and fish from May to November, when because of rainfall, salt production is not possible. In Chakaria Thana some forest lands in the Chakaria Sundarban forest have been used for brakish water shrimp and fish farming since 1977. In small areas of Ukhia and Teknaf, shrimp and fish are cultivated in rotation with rice.

Table-1.2

Area and Production of shrimp farm by new district

District	Area in hectare	Production in Million Tons	Production kg/ha
Khulna	12817	1012	78.96
Satkhira	8009	632	78.91
Bagerhat	11012	870	79.00
Jessore	422	33	78.20
Patuakhali	42	3	71.43
Chittangong	875	83	94.86
Cox's Bazer	18667	1753	93.91
TOTAL	51834	4368	84.27

Source : BBS 1984-85 p.347.

1.3.2 Method of shrimp cultivation in Bangladesh

In Bangladesh traditional method of shrimp cultivation is Gher culture. The bengali word Gher means enclosed area. Encirclement of land along the banks of tidal rivers with dwarf earthen dikes to control the free entrance of saline water into the enclosed areas was controlled by small wooden sluice boxes. From February to April, sluice gates are opened to allow the entry of salt water varieties of fish and post larvae of shrimp which breed in the sea and the estuarine waters. The young of fish and shrimp thus trapped inside the enclosures are allowed to grow until they attained harvestable size. In the starting of monsoon season, shrimp and fish are harvested and the rain water would dilute the brakish water inside the ghers. Sluice gates are opened periodically to drain out water from inside the enclosures. The monsoon rain and successive draining of water would lease out salinity and make the land inside the enclosures fit for paddy cultivation. Farmers would then raise a crop of paddy between late July and December. This type of shrimp -fish cultivation is known as Bheri fish culture.

In the traditional type of ghers, where juveniles of fish and shrimp are allowed to enter ghers with tidal water during spring tides through sluice, a number of shrimp and fish would be available inside the gher. This practice of natural stocking in the gher is being progressively replaced by artificial stocking of the ghers with the young of desired species of shrimp.

1.3.3 Patterns of shrimp cultivation in Bangladesh

There are three basic patterns of shrimp cultivation in Bangladesh. These are :

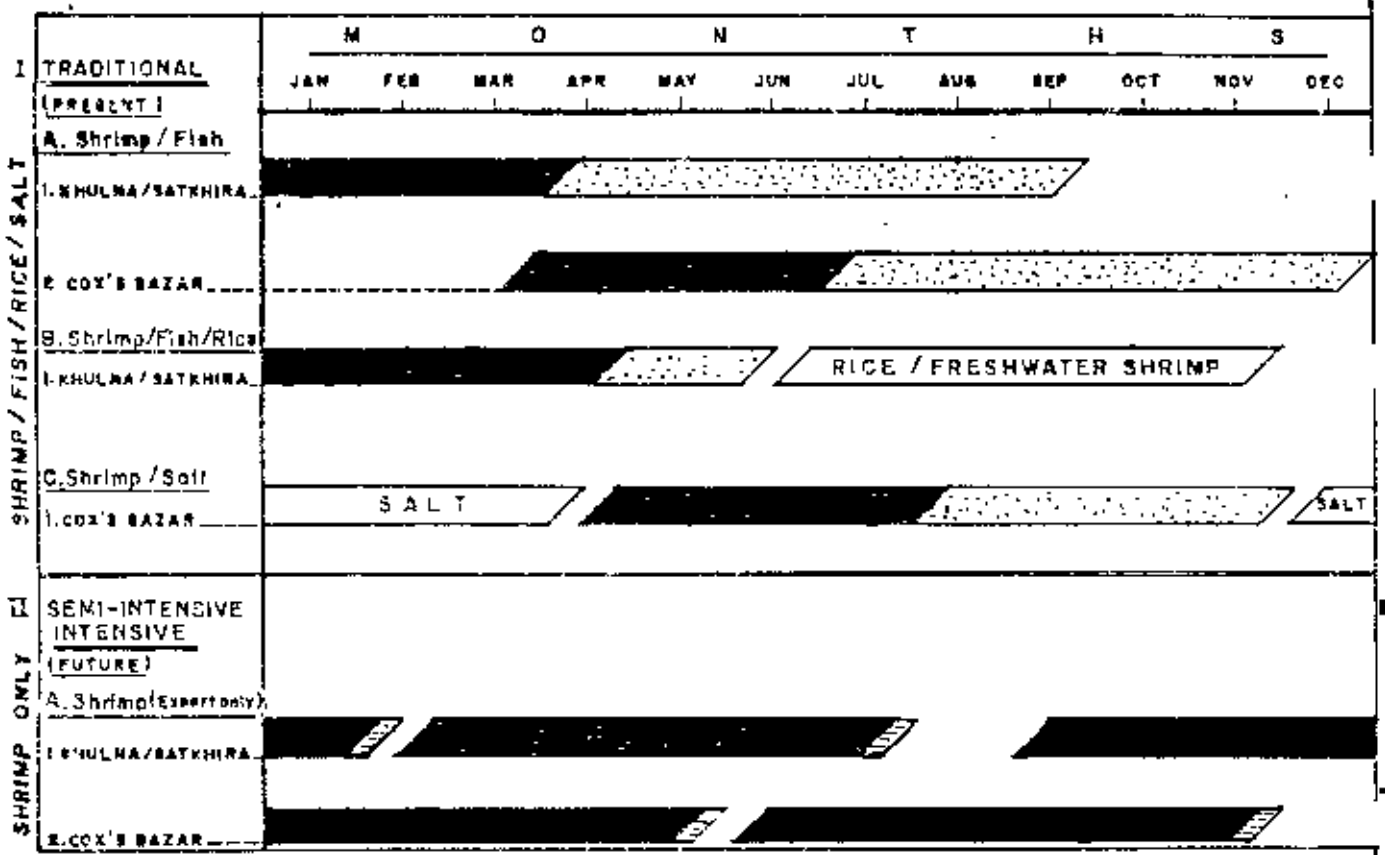
a) Shrimp as the only crop
b) Shrimp culture followed by paddy cultivation
c) Shrimp culture followed by salt production.

1.3.3.1 Shrimp as the only crop

The preparation of shrimp ghers usually starts in December and January. The preparatory work involves repairing the dwarf embankments , water control structures and inlet screens. The land inside the gher is not generally limed or fertilized. The first exchange of tidal water into the ghers is done during January-February. Exchange of tidal water is carried out during the spring tides for four to five days during the early part of the shrimp culture season. Stocking of Shrimp post-larvae starts in December-January and continues up to June-July. The peak season of shrimp post-larvae availability is February-March. During this season, particularly in the new and full moon period, when the abundance of post-larvae in tidal rivers and channels is the highest, shrimp post-larvae are taken into the gher along with tidal waters during the high tide. The high tide water energy is so manipulated at the sluice gates as to ensure the entry of only the tap portion of the water column into the ghers. The surface of the water is believed to contain the maximum of shrimp post-larvae.

FIGURE 1.2

BANGLADESH
BRACKISH WATER SHRIMP AND FISH CULTURE CROPPING PATTERN



LEGEND:

- Growth / Production of Shrimp
- Growth / Production / Harvest of Shrimp
- Shrimp Harvest
- Rice / Freshwater Shrimp Crop or Salt.

Note:

Brackish water required throughout growth and production period is 1-5 % of the total water volume exchanged / day

Source : MPO, 1987, P. 2-18

Feeding of the post-larvae is generally not done. The stocked material depend on the natural food available inside the gher for growth and sustenance.

When shrimp individuals have attained an average weight of 35 grams with head on, harvesting starts. Harvesting usually begins in the first week of April. Peak harvest of brakish Water shrimp occur during the full and a new moon period in June and July. Harvesting is done by taking advantages of the grown up shrimp instinct to swim against the flow of the coming tidal water. Bamboo traps are placed in front of water inlets. The grown up shrimps are funneled into the traps while swimming against the water flowing through the inlet canal. Another method of harvesting is to concentrate the shrimp in a catchment pond and catch them with cast nets.

1.3.3.2 Shrimp culture followed by paddy cultivation

In this pattern, one crop of transplanted rice is grown between July and November and shrimp is grown between February and June. Under this system, the harvesting of brakish water shrimp is completed by June or July before the water salinity decrease below the tolerance limit of brakish water shrimp.

Saline water from the inundated field within the ghers is drained out by the end of July. There after, rain water is allowed to accumulate and is drained out to remove salinity of the field. In this process when land becomes suitable for planting, the

transplanting aman paddy seedlings are transplanted. Ploughing is generally not done in the field. After the plantation of transplanted aman paddy seedlings, rain water is allowed to accumulate inside the gher to flood the land to a depth of 60 to 100 cm. By November or early December harvesting is done.

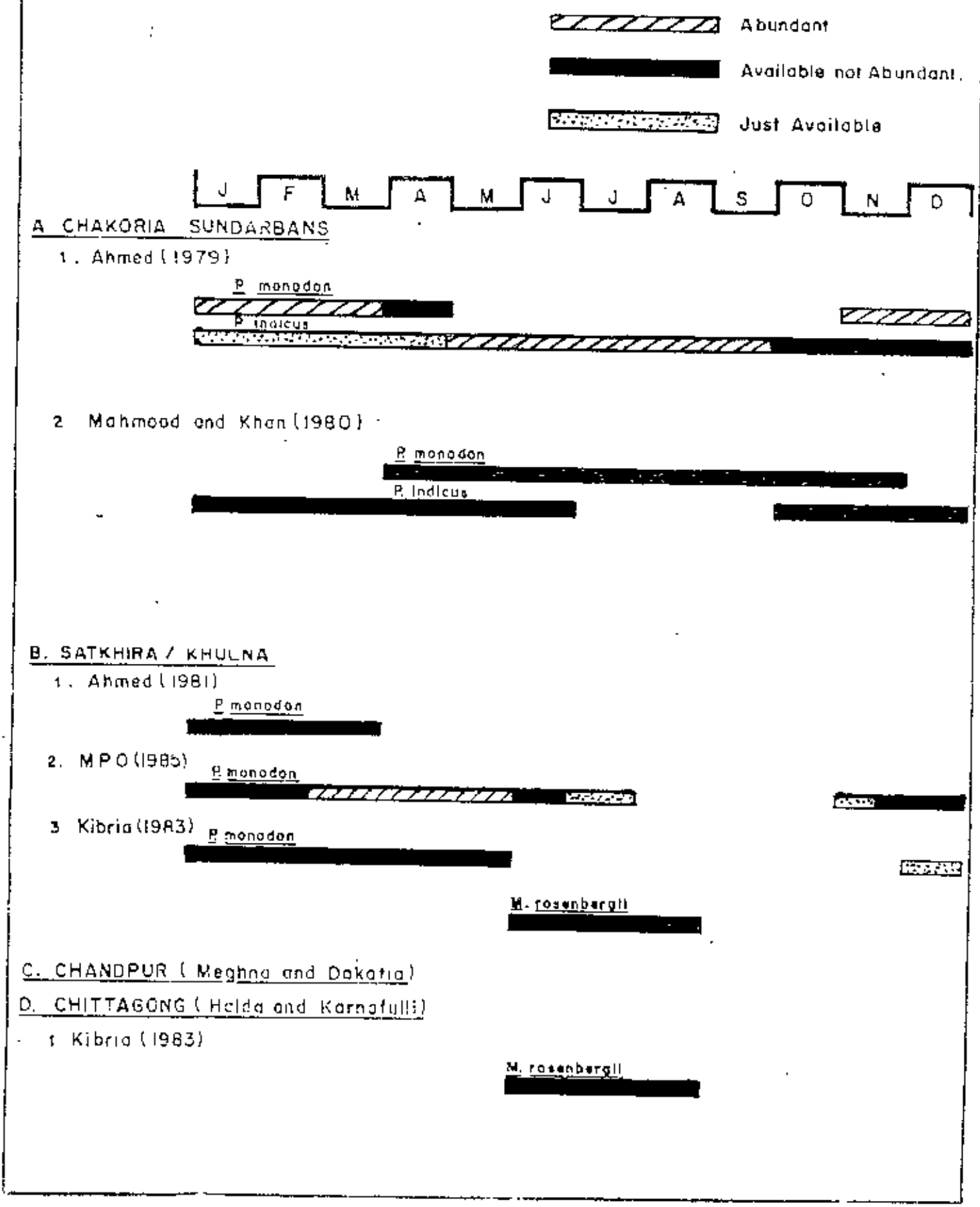
1.3.3.3 Shrimp culture followed by Salt production

In this pattern, Salt is produced during dry months using solar energy. Salt beds are encircled with low earthen dikes where salt water is brought in, preserved and evaporated between November and April. Between May and October, When salt cannot be produced because of the rains, the land are used for growing a crop of brakish water shrimp.

1.3.4 Shrimp seed collection

Though most of the shrimp farmer stock shrimp juvenile in their pond with tidal water, the practice of obtaining stocking materials by the pond owner from the seed gatherers and suppliers is increasing and an increasing number of people are becoming seed collector. Collection of shrimp post larvae and juveniles, specially Bagda shrimp is very extensively undertaken in tidal water, mangrove estuaries, creeks, shallow bank etc. Post larvae of Bagda shrimp occur throughout the year in the estuaries at the vicinity of aquaculture farm but in higher densities during pre and early monsoon months (Fig. 1.3). Fine meshed nylon nets are used to collect shrimp post larvae and juvenile. Two types of net are used.

FIGURE 1.3: RELATIVE ABUNDANCE OF SHRIMP POST-LARVAE IN THE COASTAL REGIONS OF BANGLADESH



Source : MPO, 1987, P. 2-33

These are : (1) Set net and (2) Push net. The set net is placed at right angles to the bank with the aid of a fixed bamboo pole facing the tidal current. The catch of zooplankton are periodically checked and the desired post larval Bagda shrimp are quickly shorted out. Then shorted shrimp post larvae are kept in a container with river water and the rest are discarded along the shore.

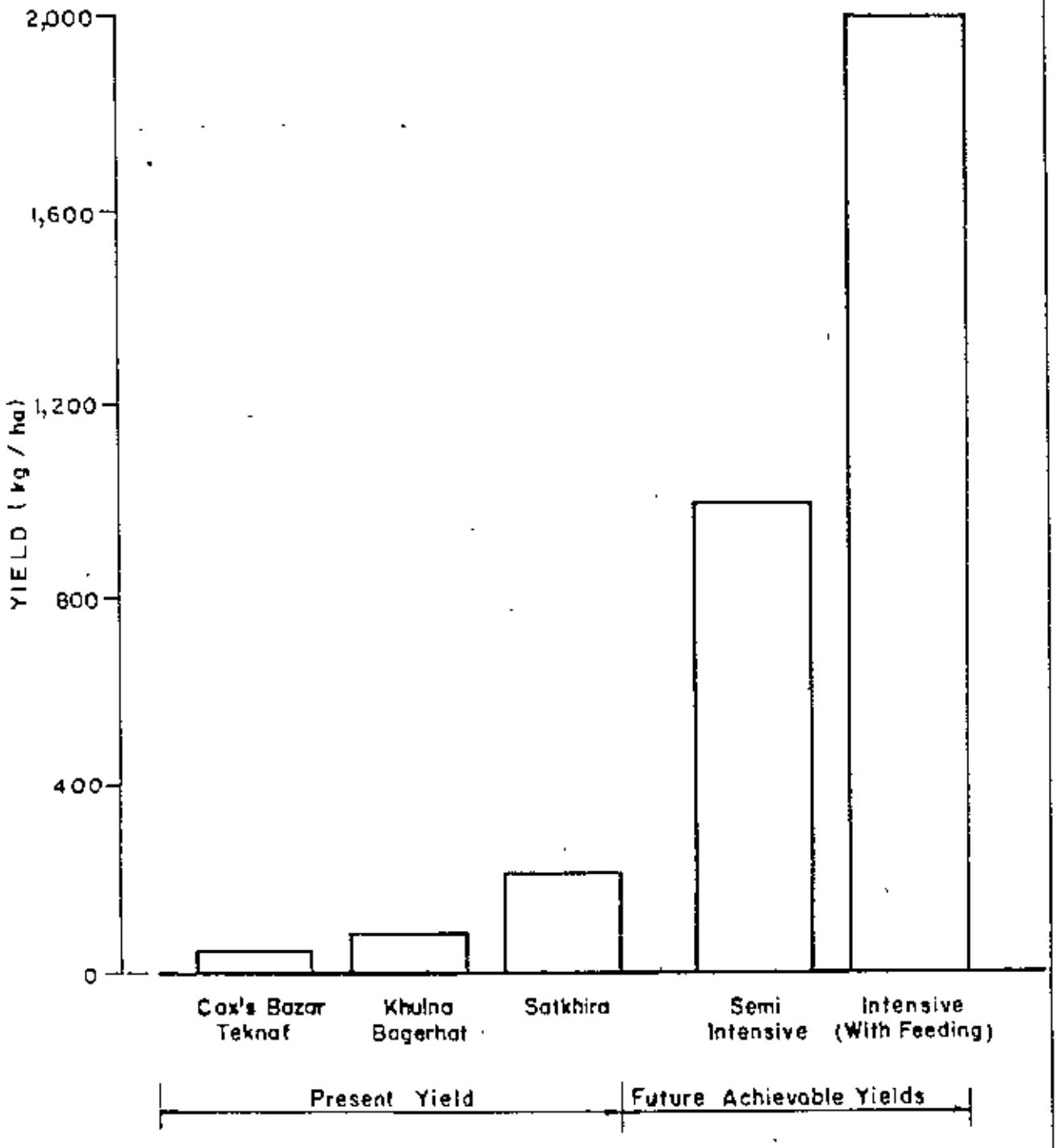
On the other hand push net is a small triangular net held by a collapsible bamboo frame and made into a cone shaped collecting bag. This is dragged in shallow water along the river bank and in the tide pools by one person. Periodically, the catch is checked, shrimp post larvae are shorted and the rest are thrown along the river bank. Among two, the later are used frequently by the minor children and earn about 40 - 50 Taka per day.

1.3.5 Potentialities of shrimp cultivation

There is a great potentialities for shrimp cultivation in Bangladesh. About 68824 hectares of land was under shrimp cultivation in 1984/85 (Table 1.3) and in 1987/88, shrimp farming area in Bangladesh is about 115,000 hector (Mahmood,1988). But the yield of shrimps is very low and it varies by localities from around 50 kg/ha of Bagda Chingree in the Chittagong region to nearly 160 kg/ha in Satkhira (Jalal.1988). The national average production is about 120 kg/ha/year (Mahmood,1988). On the other hand, the yield of shrimp in Thailand is of the order of 250 kg/ha (Jalal,1988) and Taiwan has a national average production

FIGURE 1.4

PRESENT AND FUTURE SHRIMP YIELD (kg/ha) FROM COASTAL BRACKISH WATER AQUACULTURE



Source : MPO, 1987, P.2-26

of 12 tons/ha/year (Mahmood,1988). So, it can be said that our shrimp culture system has expanded horizontally, and not vertically.

Table -1.3
Number, area and size of brackish water shrimp farm in the coastal districts of Bangladesh

District size(ha)	Upazila	Number	Area(ha)	Average
Khulna (1982/83)	Baitaghata	174	4,544	26.1
	Dacopa	191	3,302	17.3
	Dumuria	108	528	4.9
	Koyra	127	648	5.1
	Paikgacha	400	3,801	9.5
	All	1,000	12,821	12.8
Bagerhat (1984/85)	Bagerhat	24	122	5.1
	Fakirhat	37	2,138	57.8
	Kachua	38	57	1.5
	Mongla	117	3,887	33.2
	Morelganj	5	81	16.2
	Rampal	225	13,664	60.7
	Swarankhola	5	6	1.2
	All	451	19,955	44.2
Satkhira (1984/85)	Assasuni	65	2,156	33.2
	Debhata	92	4,599	50.0
	Kaliganj	115	3,190	27.7
	Satkhira	57	2,321	40.7
	Shyamnagar	46	617	13.4
	Tala	2	357	178.5
	All	377	13,240	35.7
Cox's Bazer (1984/85)	Cox's Bazer	159	5,187	32.6
	Moheshkhali	95	5,571	58.6
	Kutubdia	40	413	10.3
	Chakaria	152	9,175	60.4
	Ramu	5	15	3.0
	Ukhia	55	410	11.7
	Teknuf	85	697	8.2
	All	571	21,468	37.5
Others			1,340	
Total			68,824	

Source: ESCAP, undated, p.47.

Recently, the HANAQUA GROUP, a distinguished professional shrimp farming organization of Taiwan conducted a field survey in the coast of Cox's Bazer and was of the opinion - "It may be possible to produce as much as 6 metric tons of shrimp/ ha/ crop. Based on this field survey, it is firmly believed that in an ideal site location, a minimum of 3.5 metric tons/ ha/crop using 'state of the art' technologies is very much realistically possible to produce. Based on 1987 price and cost of land calculated at Tk. 30,000/acre, a financial analysis on a modal of a 10 hector of shrimp farm in Bangladesh, with variable inputs, showed a minimum return on investment (ROI) of 97% and annual profitability of 41% based on the annual production of 115.5 metric tons from the farm" (Selim,1988 quoted in Mahmood,1988). In view of this potentiality, if we can produce only one metric tons/ha/year of shrimp, the total yield stands at 115,000 metric tons of shrimp in land under shrimp farm in 1988. which is more than six times of shrimp exported from Bangladesh in 1989/90.

1.3.6 Institutional setup involved in shrimp culture

Shrimp is an important item of the fisheries sector of Bangladesh. Institutions and agencies involved in fisheries sector are more or less related to the shrimp culture. There are several organizations and institutions which are directly or indirectly involved in fisheries and aquaculture development.

However, the principal organization responsible for fisheries

development and management is currently the directorate of fisheries (DOF) with its marine and inland wings. The DOF is under the administrative control of the Ministry of Fisheries and Livestock (MOFL), Government of the People's Republic of Bangladesh. Apart from DOF two other agencies related to fisheries development exist under the administration umbrella of MOFL. These are the Bangladesh Fisheries Development Corporation (BFDC) and the Fisheries Research Institute (FRI).

Beside MOFL, several other Ministries and Govt. agencies are directly or indirectly involved in or associated with fisheries administration , management and development activities. Various institutions and Govt. agencies involve in fisheries development have been presented in appendix - B.

Apart from government agencies, many of the Non-Government organization such as Bangladesh Rural Advancement Committee (BRAC), Christian Commission for Development in Bangladesh (CCDB), Caritas Bangladesh, Proshika, Grameen Bank etc. are also involved in Fisheries development of Bangladesh.

From appendix-B and above discussion, it is seen that numbers of Ministry and Non Government Organization (NGO) involve in shrimp culture may creat confussion about role and activities of institutions in shrimp resource development. Sometimes activities overlap among institutions. It is important to mention here that Ministry of Environment and Forestry have no role in shrimp culture though Environment is limiting factor and public concern in this respect.

1.4 Review of Literature

Shrimp culture in coastal area of Bangladesh is relatively a new practice and this has not been much studied. A few attempts have been made to investigate into the various environmental and Socio-economic impacts but this remained scattered and uncoordinated. A study by World Bank regarding shrimp culture in Bangladesh has the following observation:

> Fisheries export have become a major source of Foreign exchange US $ 76 Million in 1983-84. Export have grown more than 20% per annum over the past decade (70's) With shrimp providing more than 80% of the value, and now exceed the value of leather and leather product export traditionally the country's second most important export category after jute and jute products. Govt. of Bangladesh has a principal objective to increase export earning from fisheries , including shrimp (World Bank, 1985, P.25).

The World Bank also reviewed the fisheries subsector in 1983 and recommended to develop semi-intensive shrimp culture in coastal ares to promote export earning.

The Bangladesh Netherlands joint project team also address the export earning objective through shrimp culture (FAO.1986). They projected that in 10-20 years time, a production area of 100,000 hector with an average farm price of shrimp and fish of Taka 100/kg would result in a production value of Tk. 15,000 million.

In a study by Alam, Elahi and Shamsuddin (1989), some of the negative effects of shrimp culture are identified. These are: 1) Siltation, which hamper rice production, 2) Conversion of grazing

land into shrimp pond reduce the availability of food for the livestock, 3) Salinity makes fresh water unusable both for the population and livestock and 4) Disappearance of Vegetation due to excess salinity and inundation.

A study by Mahmood (1985, quoted in Ahmed et. el. 1990) also pointed out that though shrimp farming has a tremendous potentials for development in the coastal Bangladesh and the economy of Bangladesh as a whole, the destruction of natural vegetation and mangrove forest are some adverse effects which have resulted from shrimp farming.

Nuruzzaman (1990) in his study showed that after shrimp cultivation, both percentage of land under paddy cultivation and yield of paddy per unit area decreased . On the other hand, production of salt per unit area increased.

A study by Aftabuzzaman (1990) identified six changes due to the construction of embankment which are required for shrimp farming. These are :

1) Hydro-morphological changes
2) Changes on Bio-system
3) Changes on Eco-system
4) Changes on Soil fertility
5) Effects on National health and nutrition and
6) Changes on Rural economy and Social Structure.

Rabanal (1982), in his study identified some Environmental impacts of Acquaculture Development. According to him, the negative effects are:

1) Effects of clearing or reclamation of forested areas viz. a) destruction of spawning and nursery ground of many species of finfish, crustaceams, malluses and other aquatic resources, b) removal of the resources of aquatic fertility, c) negative effects of vegetation clearing resulting local change in climate region.

2) Effects of mass utilization of wild fry
3) Effects of the use of various pesticide
4) Spread of diseases and pest through introduction and stock crowding.

And the positive effects are:

1) Fuller utilization of resources
2) Aquaculture is a source of additional natural stock
3) optimum utilization of site suitable for aquaculture

Chowdhury (1986, quoted in Hasan. 1990) noted that improve pond management practice along with maintenance of proper controlled sluice and dykes could increase the yield of shrimp profitably. Careful attention to predator control and proper acclimation of post larvae during stocking are the two most important factors which could enhance production considerably.

Hasan (1990) in his study reports that the average annual yield from the country's shrimp farm was 253 kg/ha and coastal aquaculture yield 22050 tons of shrimp in 1986-87. Though that production figure was quite low by the international standard, the economic return from that farm was high because of relatively less capital investment. He also added that the adequate supply of shrimp post larvae is one of the major problem of the shrimp industry. Additional to that he told that in some cases where ponds were prepared and fertilized prior stocking and well

constructed sluice gate with screen had yield upto 500 kg/ha of shrimp with little or no supplemental feed.

A study by Jalal (1990) indicates that shrimp farming has given rise to some environmental problems including the loss of grazzing land, loss of sources of fresh water and a reduction in tree cover owing to the rise of salinity. The rice yield may not so far have been affected by shrimp field. But over time, there will be an accumulation of salt lowering the yield and forcing land owner to sell land permanently to the shrimp farmer. He pointed out that there is a lack of integration of ecological environmental consideration into planning for a truly multi-sectorial aporoach to project design and implementation. Without such an approach, development efforts can not be sustained over the long run. He recommend to mandate an Environment Impact Assessment (EIS) for all coastal resource development project at the first step of planning. About shrimp cultivation, Jalal has the following observation :

> The spread of shrimp culture has been unplanned, unco-ordinated and essentially uncontrolled. In some instances land both suitable and unsuitable for shrimp have been flooded with saline water. As the intensity (unit productivity) of shrimp culture increases, it is imperative that this occur on the most suitable land preserving the remainder forest (Jalal, 1980.P.72).

Mahmood (1986, quoted in Mahmood,1988) in his study have indicated some socio-economic and environmental problems due to unplanned shrimp farming expansion. These are:

1) Destruction of valuable mangrove forest;
2) Gradual reduction of areas under rice cultivation and crop failure, food shortage and scarcity of vegetable;
3) Scarcity of drinking water;
4) Reduction of cattle grazing land;
5) Fuel crises;
6) Violation of law and social unrest;
7) Expansion of shrimp farming on the bank of rivers and canal outside the Water Development Board embankment, results in siltation and reduction of nursery area of immigrating postlarvae and emigrating juvenile of shrimp and fin fish;
8) Increase of landless farmers;
9) Exploitation of labourers;
10) Destruction of country way and paths.

Shrimp culture also has some socio-economic impacts. Most important of them are Employment and Income. Employment in shrimp shrimp is generated in the farm, in fry catching, in deheading center and in ice factories. Shrimp cultivation requires lower amount of labour. Some cases it may be even one forth of labour force employed in agriculture. Only 25 to 30 man days of labour required for one acre of shrimp cultivation, whereas 93 to 108 man days required for cultivating Aus or Aman paddy (Chowdhury, Rahman and Chowdhury, 1990, P.5). If employment in fry catching and deheading are included, additional 32 mandays (26 for fry catching and 6 for deheading) required per acre (MPO,1987, P.2-37 and 2-40).

In respect of Socio-Economic impacts of shrimp cultivation Chowdhury, Rahman and Chowshury (1990) have the following observation:

> The poverty is stark, naked and very deep, landlessness and land concentration have been proceeding at as alarming race. The existing land holding system in the area presents an extreme inequality in the ownership

> and control over land which is characterized by small minority monopoly. Thousands of farm labourer have been rendered unemployment along with a large number of share croppers evicted from the land (Chowdhury, Rahman and Chowdhury, 1990, P.6).

From the above discussion, it is clear that all study related to the shrimp culture in Bangladesh have general comments about Environmental impact of shrimp cultivation. There is no attempt to asses the Environmental impacts according to shrimp cultivation patterns. The present study try to identified and asses the impacts of shrimp cultivation on Environment according to the cultivation patterns.

1.5 Objectives of the study

The broad objective of the study was to assess the environmental effects of shrimp cultivation quantitatively at micro level and provide some guidelines which would be environmentally acceptable without reducing the shrimp production at the same time. The following objectives had been set for the study:

a) To identify and assess the effects on siltation;
b) To identify and assess the effects on salinity;
c) To identify and assess the effects on vegetation;
d) To provide some policy guidelines in order to minimize these effects;

1.6 Hypothesis of the study

It had been hypothesized that the present patterns of shrimp cultivation is not appropriate for the environmental condition of the coastal areas of Bangladesh.

1.7 Methodology of the study

The methods adopted for the study consist of three aspects viz:

1) Land classification;

2) Sample frame and

3) Approach to analysis

Land was classified according to its farming pattern. These are:

1) Shrimp as a mono culture;

2) Shrimp cultivation followed by salt production and

3) Shrimp cultivation followed by rice production.

A multi-stage Sampling procedure was applied for the present study. The Sampling framework adopted was as follows:

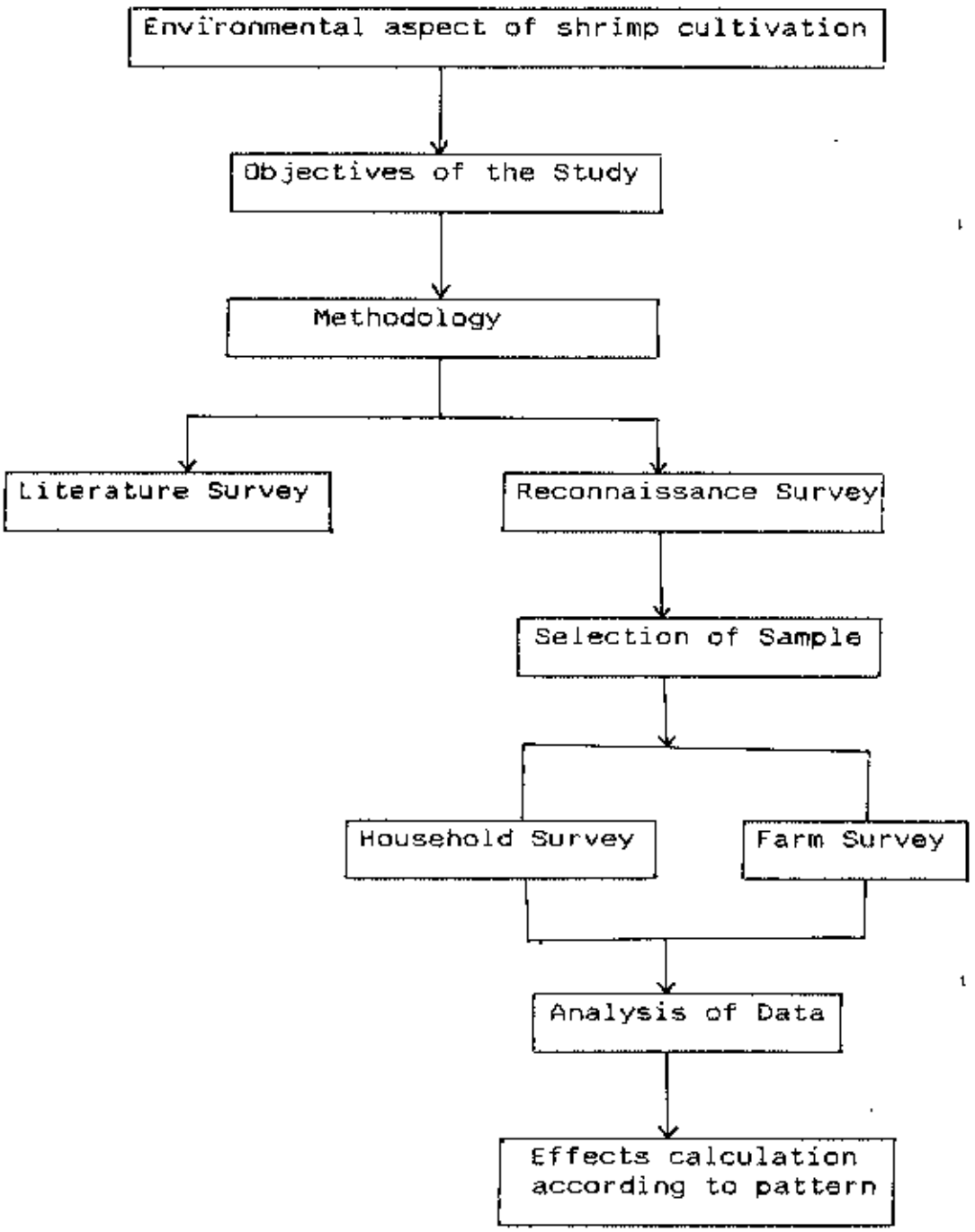
Step-1 : Selection of Thanas;

Step-2 : Selection of village and Listing of Farms and Households

Step-3 : Stratification of shrimp farm according to use pattern;

Step-4 : Selection of sample farm and household from each pattern.

Figure 1.5 : Flow diagram of Methodology of the study.



1.7.1 Selection of the study Area

Shrimp cultivation is concentrated in two regions of Bangladesh. These are - Khulna in the south-west and Cox's Bazer in the south-east. The study objectives were to analyze environmental effects according to use pattern, viz. only shrimp, shrimp-salt and shrimp-paddy. But shrimp-salt pattern of shrimp cultivation is very uncommon in Khulna region. So Cox's Bazer region was selected as the study area. In Cox's Bazer region shrimp culture is practiced mostly in six Thanas. These are Kutubdia, Moheshkhali, Cox's Bazer, Ukhia, Teknuf and Chakaria. Among these Thanas only shrimp pattern is practiced in Cox's Bazer, shrimp cum salt pattern is practiced in Kutubdia, Moheshkhali and Chakaria and shrimp-cum-paddy pattern is practiced in Ukhia and Teknaf. Cox's Bazer Thana was choosed for only shrimp pattern and from others Thanas, Moheskhali and Teknaf were for the shrimp-salt and shrimp- paddy pattern of shrimp culture, respectively.

1.7.2 Data collection

Two types of data were collected for the present study. These are - Primary data and Secondary data.

A) Primary data collection :

To collect primary data Questionnaire survey technique were used. Two sets of Questionnaire - Farm and Household was prepared and were operated by a team of five local members who was educated and had knowledge about local people and condition.

Before survey was performed, sample household and farm was enumerated. From each Thana, 100 household and 10 farm were selected. In this respect, at first 5 mouzas from each Thana were selected on the basis of the proximity to shrimp farm. Then 100 household and 10 farms from each selected 5 Mouzas were selected ramdamly. The following tables present the sampling procedure:

Table -1.4

Selection of the Mouzas and Households

Name of the Thana	Union			Mouza			Household		
	Total	Selected	%	Total	Selected	%	Total	Selected	%
Cox's Bazar	7	3	42.9	8	3	37.5	7014	100	1.41
Moheshkhali	7	3	42.9	16	6	37.5	6725	100	1.28
Teknuf	5	3	60.0	8	3	37.5	5822	100	1.72

Sources: BBS, 1989, Zila Series, Cox's Bazar

Table -1.5

Selection of sample farms

Name of the Thanas	Total Number of Farms	Selected Number of Farms	Percentage
Cox's Bazar	159	10	6.3
Moheshkhali	95	10	10.5
Teknaf	85	10	11.8

Sources: BBS, 1989, Zila Series, Cox's Bazar

8) Secondary data collection

Secondary data were collected from a number of published or non-published books and materials. Various reports of Bangladesh Bureau of Statistics (BBS), Technical reports of Master Plan

Organization (MPO), reports of Bangladesh Water Development Board (BWDB) and others Working and Seminar paper are used for this purpose.

1.7.3 Data Analysis

Collected data were analyzed in percentage and presented it in tabular form for each pattern for discussing the effect of shrimp cultivation. Environmental Impact Assessment Technique was used to measure the anticipated changes. The method of Environmental Impact Assessment have discussed in appendix C. This method was developed by modifying the method developed by Fotis Chatziniks (1988). It provides a basis for determining whether or not a particular project has any significant impact on the quality of human environment and whether that project is environmentally acceptable or not.

1.8 Limitations of the study

The study was done within a limited time and resource constraints. Apart from these, publications are very limited and scattered about the shrimp culture in Bangladesh because it is a new field of study. So information relevant to this research were mainly collected through a primary survey, observation, interview and finally the author's Judgment and experience.

The environmental effects of shrimp cultivation can be studied at micro, meso and macro levels, vertically as well as horizontally,

both in short and long run. This study assessed only the micro level, horizontal effects of shrimp cultivation in a short run.

1.9 Organization of the study

The present study has been divided into six Chapters. Chapter one presents general description of the coastal area, Contribution of shrimp in the economy, Historical development of shrimp cultivation, Method of shrimp cultivation, pattern of shrimp cultivation in Bangladesh, background of the research work along with the review of literature. The objectives, hypothesis, methodology, Scope an limitation and organization of the study are also discussed in this chapter.

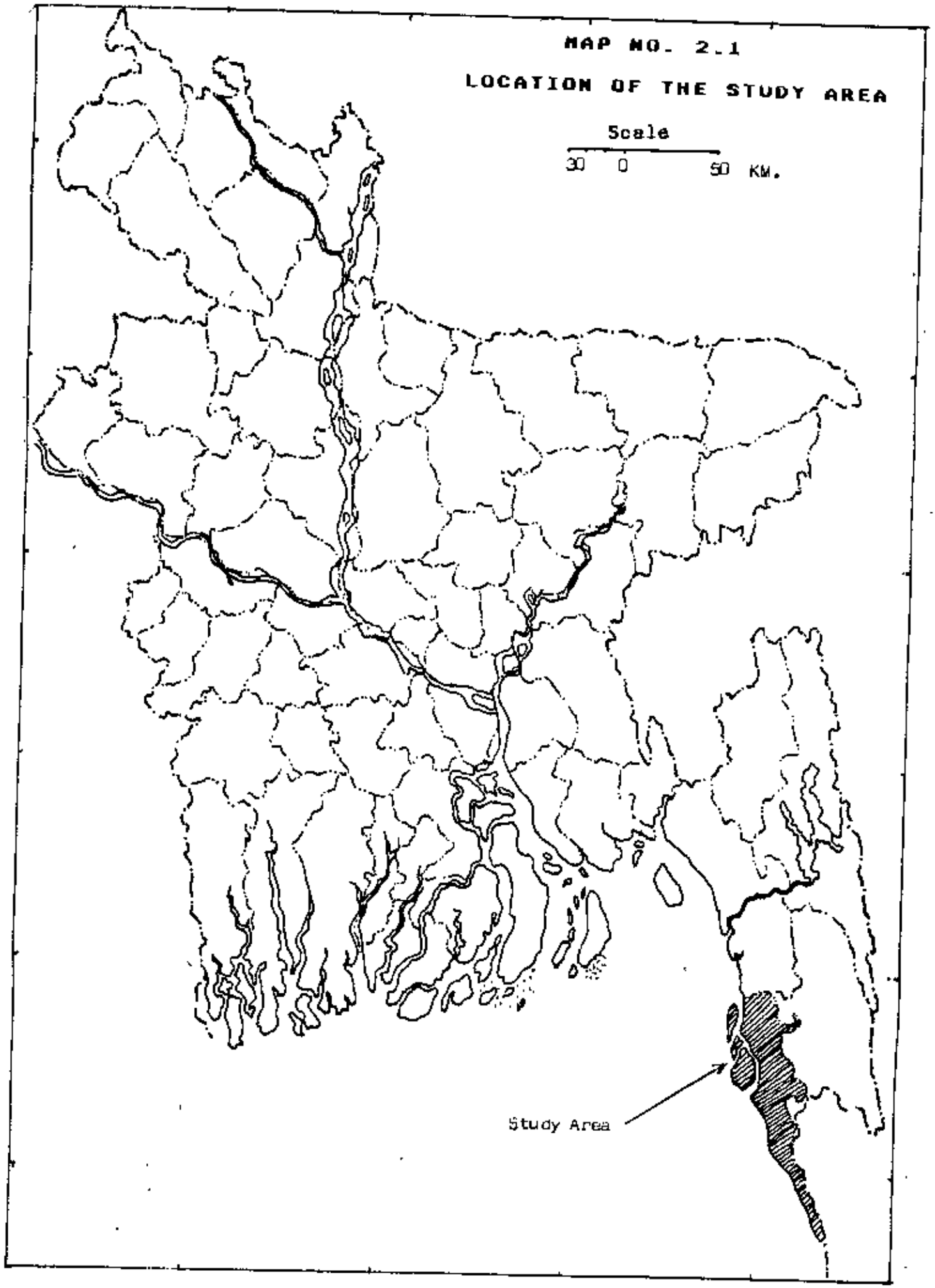
Chapter two deals with the selection of the study area, Socio-economic condition, climate, land and cropping pattern of the study area.

Chapter three deals with the effects of shrimp cultivation on salinity.

Chapter four deals with the effects of shrimp cultivation on siltation.

Chapter five deals with the effects of shrimp cultivation on vegetation.

Chapter six provides a summary of the findings , concluding remarks and some recommendations as a general guideline for minimization of Environmental degradation.


MAP NO. 2.1
LOCATION OF THE STUDY AREA
Scale
30 0 50 KM.
Study Area

CHAPTER TWO

THE STUDY AREA

2.1. Location and general characteristics of the study area

Cox's Bazer district lies in the extreme south east corner of Bangladesh between $20^{0}42$ and $22^{0}05$ north latitude and $92^{0}22$ and $91^{0}15$ east longitude. The district is bounded on the west the Bay of Bengal, on the north by Chittangong district, on the east by Bandarban district and on the south and southeast by the river Nuff which separate the district from Arakan (Rakhain) of Burma (Myanmar).

Cox's Bazer district consists of seven Thanas - Kutubdia, Moheshkhali, Chakaria, Cox's Bazer, Ramu, Ukhia and Teknaf. It occupies a physical area of 2277 sq. km. of which 99 sq. km. is river and 873 sq. km. is forested.

The district in shape resembles an acute-angled triangle; the Matamuhuri river in the north, the coast line in the west and the eastern hill range and Nuff river in the east forming the three lines with its apex terminating in the promontory of Teknuf. It has a long trip of coast and long range of hills with valleys. The Cox's Bazer sea beach prominent in the country as well as in the world as a tourist spot is within this district.

There is a galaxy of islands included within the district separated from it by narrow channels. They are Kutubdia, Moheshkhali, Materbary, Sonadia, Shahpuri, St. Martin which is a small coral island and other small islets. Except Moheshkhali and St. Martin island all others are alluvial and low lying plain land, very rich and fertile. Moheskhali has hills with conical peaks, covering its eastern and central part.

The Matamuhuri, the Bankkhali, the Raju and the Nuff are the Main rivers of this district. All the rivers rise from the hill range of North Arakan, flows toward west and fall into the Bay of Bengal except he Nuff. The Nuff Flows toward south and falls into the Bay of Bangal after divides Cox's Bazer from Arakan of Burma. In addition to these rivers there are some creeks in mainland and in the islands. All the rivers and creeks of the district falling into the Bay of Bengal are tidal upto a considerable length inland.

2.2. Climate of the Study area

Cox's Bazar district is situated in the tropical zone and as such it is subject to tropical climate. But its situation with a sea to the west and ranges of hills to the east has neutralized the extreme of the climate to a considerable extent. It lying along the sea coast backward by hilly region to the east which is favourable for free play of land and sea breezes. The movement of the air from a comparatively cool region towards a highly heated

plains comes a uniformity of temperature. The position of the district on the coast line of the north east angle of the Bay of Bengal helps to get the heavy rain or the moist winds of the south-west monsoon coverage in the direction. Thus the area has uniform temperature, high humidity and heavy rainfall from May to October. The climate is thus moist, warm and equable.

The average maximum temperature is lowest in December and January, when it is about 25^{0} C and highest in April, when it is about 32^{0} C giving a variation of 5^{0} C.

The humidity of the atmosphere is lowest in January and February and highest in September when it varies from 80 to 90 percent. The average normal annual rainfall at Cox's Bazer is about 81.28 cm. June-July are the months of highest rainfall in normal year. After the establishment of south-west monsoon condition in June, the rainfall becomes much heavier and there is a further increase in July after which the amount rainfall diminishes rapidly.

Cyclones is common in this area. In the Bay of Bengal, the frequencies of occurrence is highest during May and October. The depression first originate in small anti-clock wise motion and rapidly changing direction sooner become roughly circular in shape. It has no frontal structure and the wind velocity varies from 25 to 250 km per hour. The wind blowing inward in a counter clock wise since about the center of the storm, causes rapid convergence of warm, moist air, with resulting heavy

precipitation. The duration of tropical cyclone averages between a couple of hours to a week. Cyclone passed over the Cox's Bazer district in several times inflict considerable damages. In recent time, the devastating cyclone of 29th april 1991, damaged a considerable amount of wealth and life in this area especially in Kutubdia and Moheshkhali Thanas.

2.3. Vegetation of the study area

Due to high rainfall and proximity to Bay of Bengal, the Cox's Bazer region have rich vegetation. The vegetation of the high forest ares can be described as a subtropical or tropical deciduous type or semi- evergreen type. On the other hand, different types of plants are found on the low-lying or marshy areas and vegetation similar to Sundarban are found in along the coast of Chakaria Thana which is now mostly cleared for shrimp cultivation. The presence of rich marine flora are found in some remote southern coral islands, namely, St. Martin Island (Zinzira). It needs to be mentioned that the only rubber garden of Bangladesh is in Ramu Thana of Cox's Bazer district. Some aquatic plant, like, Challa, Guam, Sheora etc. are found in swampy and semi-dried swampy areas and along Charas. Nol Khagra, Dal Ghash etc are grown along the bank of marshy pools. Mangrove forests are found in Hnila areas under the Teknuf Upazila. While going towards Teknaf from Cox's Bazer by road, one can see such mangrove vegetation from Gundhum to Teknaf. Hargaza, Keora, Gewa and Golpata are the common plants among these mangrove vegetation.

2.4. Demographic Feature of the Area

According to the preliminary report of census 1991, the population of Cox's Bazer district is 1387265 with 72385 Male and 663415 Female and the size of household is 6.34 . The literacy rate for all age is only 15.01 percent. According to survey data, 45.8 percent of the population is female and 54.2 percent is male. Occupation, education and age structure from survey data are presented in following table.

Table - 2.1

Distribution of sample population by Age and Thana

Age group	Cox's Bazar (%)	Moheshkhali (%)	Teknaf (%)	All (%)
Upto 4	10.7	13.3	10.9	11.6
5 to 9	13.0	15.2	17.5	15.2
9 to 14	14.0	13.6	17.8	15.2
14 to 19	14.3	10.6	7.5	10.6
19 to 24	13.3	7.4	8.4	7.9
24 to 29	7.9	10.6	4.2	8.1
29 to 34	9.2	5.3	4.2	5.2
34 to 39	5.9	6.4	3.9	4.8
39 to 44	4.1	3.5	9.5	5.7
44 to 49	4.3	3.5	1.9	2.4
49 to 54	1.8	2.9	9.5	5.6
54 to 59	4.6	3.2	0.0	2.7
59 to 64	1.8	1.3	2.8	2.0
64 and above	4.3	3.2	1.9	3.2
Total	100.0	100.0	100.0	100.0

Source : Field Survey, 1991.

Table 2.1 presents the population composition of three Thanas in percentage. The distribution is even and consistent among the Thanas. About 40% of the population is in the young age group of

below 14 years and more or less same percentage is observed in the three Thanas. The working (14 to 59 years of age) population is 66%, 53% and 49% for Cox's Bazar, Moheshkhali and Teknaf Thana respectively.

Table - 2.2

Gender composition of the population by Thanas

Sex	Cox's Bazar (%)	Moheskhali (%)	Teknaf (%)	All (%)
Male	55.8	58.0	55.2	56.3
Femal	44.2	42.0	44.8	43.7
Total	100.0	100.0	100.0	100.0

Source : Field Survey, 1991.

Table 2.2 presents the gender composition of the population by Thanas. There is no significant variation in gender composition among Thanas. Table 2.3 presents the level of education of the population of study area. Moheshkhali Thana have the highest level of literacy rate (58.9%) and Teknaf have the lowest (30%). In case of higher education Moheshkhali stands first.

Table - 2.3
Level of education of the sample population (more than 5 years of age) by Thanas

Education level	Cox's Bazar (%)	Moheshkhali (%)	Teknaf (%)	All (%)
Illiterate	44.2	41.1	70.0	55.8
Primary	23.0	31.6	25.4	26.6
Secondary	9.5	18.2	4.7	11.1
Higher Secondary	4.2	4.7	0.0	3.2
Graduate	4.9	3.6	0.0	3.1
Post Graduate	0.0	0.8	0.0	0.3

Source : Field Survey,1991

Table - 2.4

Occupation of the sample population by Thanas

Occupation	Cox's Bazar (%)	Moheshkhali (%)	Teknaf (%)	All (%)
Own agriculture	11.8	7.6	15.6	11.6
Hired agriculture	4.5	1.1	0.0	2.0
Shrimp	2.5	0.7	1.2	1.5
Service & Business	5.1	3.3	1.2	3.3
Fishing	14.0	22.9	22.0	19.3
House Wife	28.3	22.2	28.0	26.2
Student	33.8	42.2	32.0	36.0

Source : Field Survey, 1991.

Table 2.4 presents the occupation of the population of the study area. This table reveals that agriculture and fishing is the main occupation of population of the study area. only 1.5% people of the area involve in shrimp cultivation. In cox's Bazar, 2.5% people involve in shrimp cultivation and in Moheshkhali it is only 0.7% . This variation exists because in Cox's Bazar, shrimp are cultivated along the year but in Moheshkhali, shrimp are cultivated in rainy season in traditional way which needs very low amount of manual labour. Though Cox's Bazar, Moheshkhali and Teknaf Thanas cover 34.78%, 25.65% and 45.05% of there cultivable land in shrimp but generate only 2.5%, 0.7% and 1.2% employment respectively.

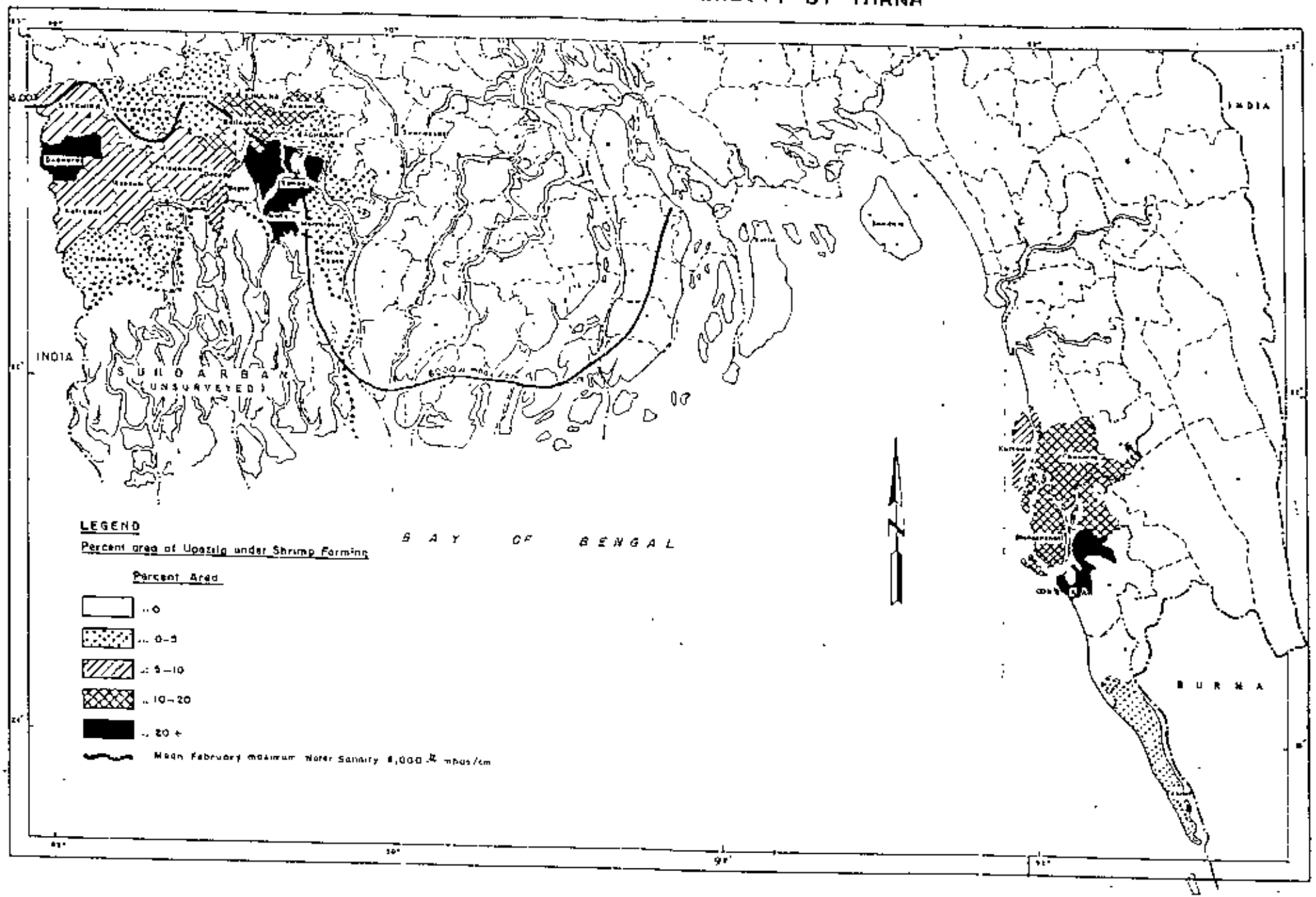
From the above discussion it can be said that though shrimp farming become a important economic activity in the coastal area but employment in shrimp farming is very low and there is significant variation in employment among different pattern of shrimp culture.

2.5. Land and Agriculture of the study Area

According to BBS, Cox's Bazer district have 74089 hectare of cultivated land of which 27530 hectare are irrigated. Per capita land availability is only 0.31 acres and the intensity of cropping is 147 (BBS,1987,Zilla Series,Khalna). The district have 87300 hectare of forest land which is about 38 percent of total area of the district. Except shrimp and salt cultivated area, the cropping pattern is more or less the same as that of the other regions of Bangladesh. Cropping season is broadly divided into Robi and Kharif. December to April is Robi and May to November is Kharif season. Rice is cultivated in most of the land in Kharif season. Two varieties of rice, Amon and Aus are grown in Kharif season depending on natural rainfall. In Robi season, some Boro rice are grown depending upon tubewell irrigation or water from hill stream. Except rice, pulses,oil seeds, chilies, sugarcane, watermelon, potato and other kinds of vegetable are grown in this area. In addition to these, Pan (belet-leaf) is the important agricultural crop of this district especially in Moheskhali Thana.Pan is grown mainly on foots of the hills.

The source of draft power for agriculture is cattle and buffalo and a large number of buffalo are found in this area compared other areas of Bangladesh.

MAP NO. 2.2 : SHRIMP FARM DENSITY BY THANA



Source : MPO, 1987, P. 2-2

2.6. Shrimp culture of the Area

Commercial shrimp cultivation in the study area is mostly a post-independence practice. Before independence, shrimps were cultivated in a small area in order to meet local demands. With the recent increase in demand and price of shrimp in the international market, shrimp farming has been expanding in this area rapidly. But this expansion is horizontal. The area of shrimp cultivation increase but yield do not increase.

Shrimp cultivation (especially Bagda Shrimp) needs saline water which is available in coastal areas of Cox's Bazer district. Shrimp are cultivated in swampy land which, most of the cases, is formed by Bangladesh Water Development Board (BWDB) embankment known to the local people as Ghona. Salt pans and/or shrimp ponds are constructed on the bank of the tidal river or creeks. Saline water from the rivers during high tide period are permitted to the shrimp ponds through sluice canal and discharged during low tide. The bank of the Matamuhuri, Bankkhali and Nuff are the frequent shrimp cultivation area in the mainland of Cox's Bazer. In Moheshkhali and Kutubdia island, old dyked salt pans are turned to giant ponds during rainy season when salt production is not possible due to heavy rainfall.

Table - 2.5

Potential areas for shrimp farming in Cox's Bazar district

Thanas	Gross Area (ha)	Potential Area (ha)	Percentage	Present shrimp farming area(ha)
Kutubdia	8,820	2580	29.25	413
Moheshkhali	31,900	14370	45.05	5,571
Chokoria	61,900	17760	28.69	9,175
Cox's Bazar	20,700	7200	34.78	5,187
Teknaf	38,070	9760	25.65	697
Total	161,390	56230	34.84	21,043

Sources : MPO, 1987.

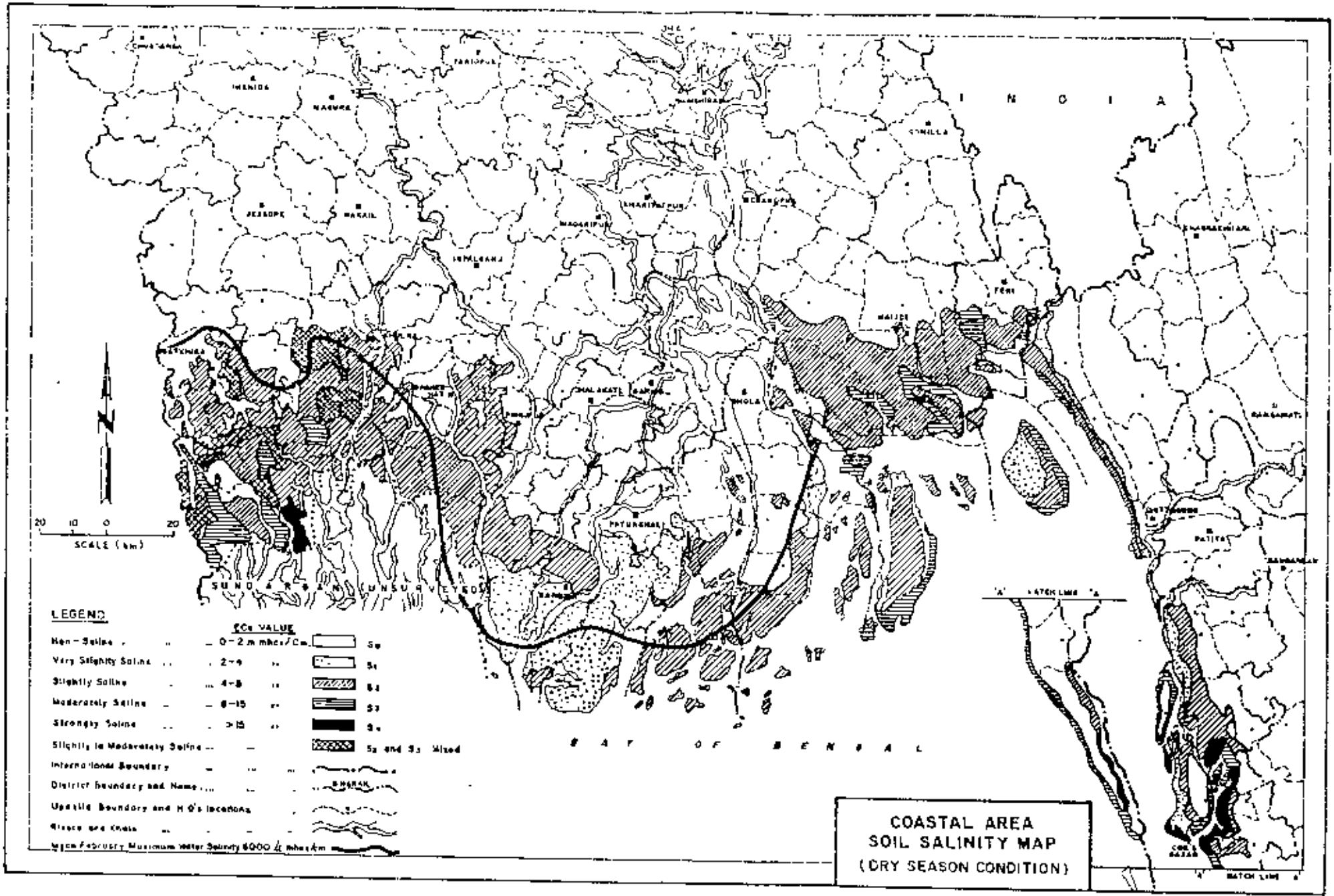
In Chakaria Thana some land of mangrove forest are cleaned and distributed among farmers in the second half of 70's for shrimp cultivation. Now most of these land are used for shrimp cum salt cultivation. In Cox's Bazer Thana, land on the bank of the river Bankkhali are used for monoculture of shrimp. In Ukhia and Teknaf Thanas, shrimp are followed by paddy cultivation . Shrimp farming Thanas of Cox's Bazer district with percentage area are shown in the Map- 2.2. The shrimp culture pattern of three Thanas is shown in the figure 2.3.

In most of the cases shrimp are cultivated by traditional method of Bheri culture. Only two farms on the north bank of Bankkhali river near Cox's Bazer town are found to practice semi-intensive type of shrimp culture. The name of these two farms are - The Allawala Farms Ltd. and The Aquaculture Farm Ltd. Both farms are privately owned and have a production capacity of about one ton per acre per year.

2.7 Conclusion

From the above discussion it can be implied that though vast amount of cultivable land are converted into shrimp farm but employment generation from it is very little. Only 1.5% of the people of the study area get employment in shrimp cultivation. Moreover, most of the land converted into shrimp farming (excluding Mohshkhali and Chakaria) was under paddy and other agricultural production which used to generate higher level of employment compared to shrimp cultivation. This has also decreased the agricultural production of the area. In addition to these , the study area have some rare species of trees and vegetation e.g. Keora forest in Teknaf in which rare species of Monkey live, are vanishing due to inundation.

MAP NO. 3.1 : COASTAL AREA SOIL SALINITY



Source : MPO, 1987, P.

CHAPTER THREE

EFFECTS OF SHRIMP CULTIVATION ON SALINITY

3.1. Introduction

In brakish water shrimp cultivation, saline water from sea are reserved in shrimp pond in which shrimp juveniles are grown and feeded. Normally it is not a problem if the ponds are used for shrimp cultivation only and if saline water do not overflow or trickled down to adjacent areas.

Shrimp cultivation in coastal areas is one kind of brakish water aquaculture which requires saline water stock and flow in farm land. Farm lands are inundated by saline water at the eve of practice and saline water is exchanged several times in the operation period which has an effect on land and water. This effect may be on drinking water used by man and livestock, on water for agricultural use, on water of river and canal which makes destruction for breeding and growth of fisheries and on the soil of the field and adjacent areas which decreases agricultural production and vegetation.

The salinity level of the water used for shrimp cultivation has some relevance with frequencies of effect on salinity both for soil and water. For shrimp cultivation, the tolerance range of water salinity is 10 to 30 ppt (parts per thousand). But depending on season and rainfall, this salinity level change from 5 to 40 ppt. The traditional farmers have no data about salinity level but two semi-intensive farms - the

Allawala Farm Ltd. and the Aquacuture farm Ltd., on the bank of Bankkhali river, near Cox's Bazar town have diurnal data about salinity level of water in the shrimp pond. From this data month wise highest salinity level are given bellow:

Table - 3.1

Salinity level (ppt) of shrimp pond water

Name of Month	Allahwala Farm	Aquaculture Farm	Average
January	30	-	30.0
February	30	-	30.0
March	30	39	34.5
April	30	34	32.0
May	28	25	26.5
June	10	15	12.5
July	08	14	11.0
August	14	17	15.5
September	18	19	18.5
October	22	24	23.0
November	24	24	24.0
December	26	24	25.0

Source : Field Survey, 1991.

3.2. Underground water salinity

Underground water is used for drinking purposes both for man and livestock and also for irrigation purposes. Increase of salinity makes drinking water unusable and decrease agricultural yield.

Underground water salinity increase due to inundation of vast land by saline water for shrimp cultivation and lifting of underground water to dilute the salinity of water in shrimp ponds in March and April when salinity of sea water exceeds the

tolerance limit for shrimp cultivation. In traditional method underground water lifting is uncommon but in semi-intensive method a huge amount of underground water is lifted in the pre-monsoon period for efficient production. So underground salinity problem may become acute in future in areas where semi-intensive form of shrimp culture is practiced.

In areas where shrimp-paddy pattern are practiced, the salinity problem is less because of desalinization in paddy culture time. On the other hand, where shrimp-salt pattern are practiced, effects of shrimp cultivation on salinity is not significant because in this pattern shrimp are grown in monsoon season when salinity of water available in shrimp pond is very little. Shrimp only pattern has considerable underground water salinity problem because lands are inundated by saline water about 10 months of the year and water with higher level of salinity is resovered in shrimp farm in March and April. Local people's view about underground water salinity increase are recorded in tables 3.2 and 3.3.

Table -3.2
Local people's opinion about the increase of underground water salinity due to shrimp cultivation

Opinion	Cox's Bazar	Moheshkhali	Teknaf	All
Yes	18 (18.0)	11 (11.0)	0 (0.0)	29 (9.7)
No	74 (74.0)	81 (81.0)	100 (100.0)	255 (85.0)
No response	8 (08.0)	8 (08.0)	0 (0.0)	16 (5.3)

Sources : Field Survey, 1991.
Note : Figure within parenthesis indicates percentage distribution

Table -3.3

Opinion of the local people about the intensity of underground water salinity increase due to shrimp cultivation

Opinion	value	Cox's Bazar		Moheskhali		Teknaf		All	
		% of response	Value	% of response	value	% of response	value	% of response	value
	(a)	(b)	(axb)	(c)	(axc)	(d)	(axd)	(e)	(axe)
Very high	5	0.0	0.0	0.0	0.0	--		0.0	0.0
High	4	11.1	55.4	0.0	0.0	--		7.0	28.0
Moderate	3	0.0	0.0	40.0	120.0	--		14.3	42.9
Less	2	55.6	111.2	40.0	80.0	--		50.0	100.0
Very less	1	33.3	33.3	20.0	20.0	--		28.0	28.0
Total Value (s)			188.9		220.0	--			198.9
Weight(w)*			18.0		11.0	--			9.7
Weight value(sxw)			3400.2		2420.0	--			1929.2

Sources : Field Survey, 1991.
* Percentage of yes responses

Table 3.2 and 3.3 reveal that in Cox's Bazar where shrimp only pattern is practiced, 18% people think that underground water salinity is increasing and the weighted value of the intensity of salinity increase is 3400.2 which is the highest among three pattern. Moheshkhali Thana (shrimp-salt pattern) stands in the second position and Teknaf (shrimp-paddy pattern) has no underground water salinity problems. This implies that among traditional patterns of shrimp cultivation, shrimp-paddy is acceptable considering the effects of shrimp cultivation on ground water salinity.

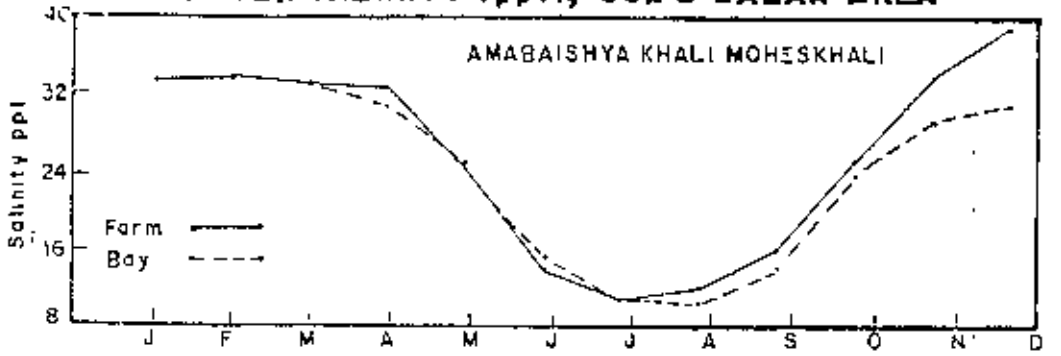
The calculated value of χ^2 (Chi) of Table 3.2 is 28.98 with 2 d.f. which is greater than tabulated value at 1% level. So, the hypothesis is rejected and there is significant difference among the responses of local people from different pattern of shrimp cultivation.

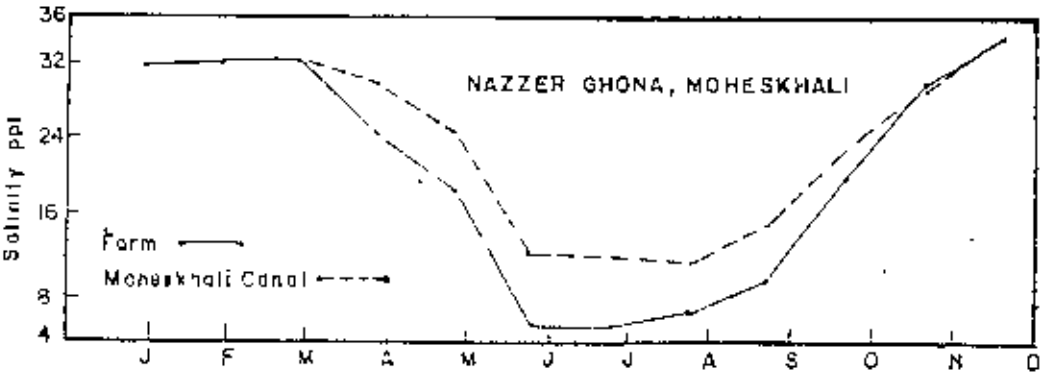
3.3. Surface water salinity

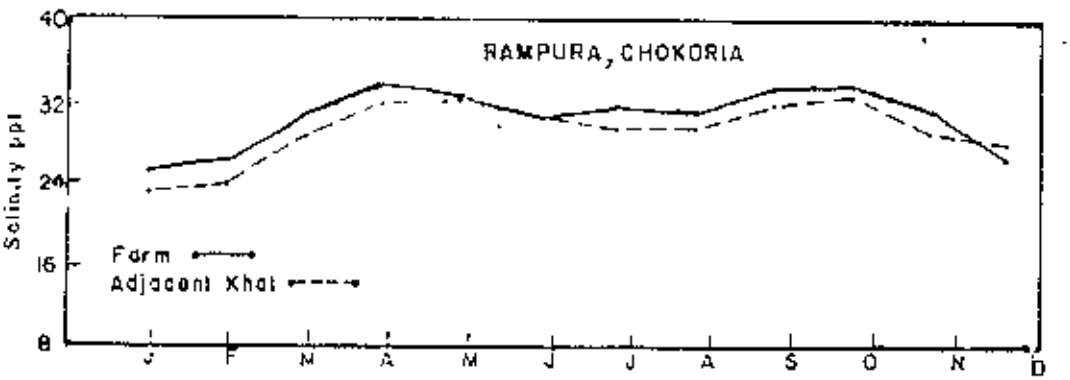
Increase in surface water salinity decrease the yield of agricultural production and hamper the growth and breeding of fresh water fish. Because of brakish water acquaculture, fresh water of adjacent water body and river are affected from saline water seepage. In Bangladesh all dykes for shrimp cultivation are made of earth. These dikes are temporary structures which enhance saline water seepage from shrimp pond to adjacent water body and river. Increase of surface water salinity also creates problem for livestock husbandry because surface water is normally used as drinking water for livestock. Figure 3.1 shows that surface water salinity is slightly less in shrimp pond than source of saline water and adjacent water body have lower salinity than shrimp pond but there is a positive correlation among them.

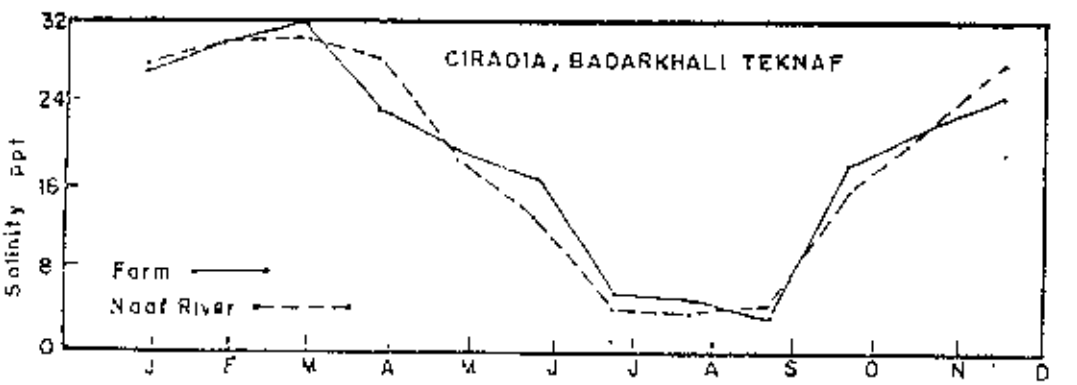
On the other hand, sometimes shrimp farmers create an artificial flow of saline water from tidal river through canal to supply saline water in their shrimp pond. It affects the level of salinity of surface water surrounding the canal in

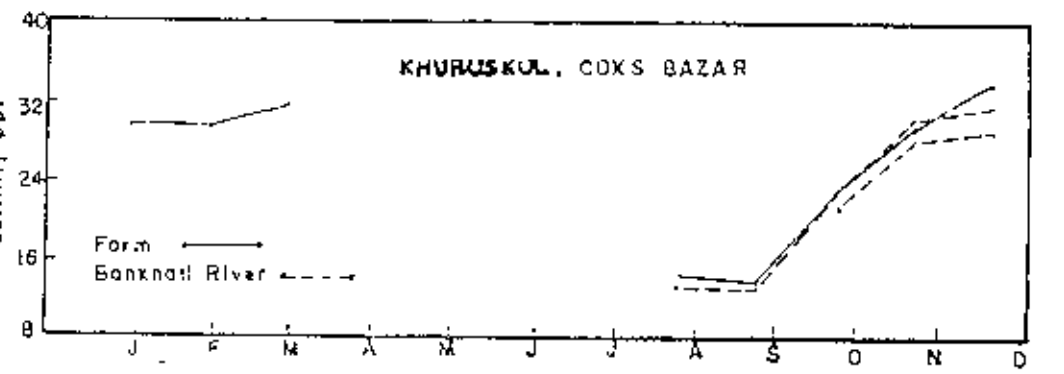
WATER SALINITY (ppt), COX'S BAZAR AREA











Source : MPO, 1987 P. 2-8

which formerly fresh water was available. These occur due to indiscriminate expansion of shrimp culture area to get higher economic return from land.

3.4. Soil Salinity

Soil of coastal areas is naturally more saline than other parts of the country. Figure 3.2 shows the surface soil salinity in different parts of Bangladesh. Saline soil produce low agricultural yield. The areas where soil salinity exceed 8,000 micro-mhos/cm remain fallow during winter season because these soils have no good potential for agricultural production in Robi season. Usually one crop of transplanted aman is grown in rainy season and gives low yield. These soils of high salinity are potential and environmentally may be accepted for brakish water shrimp aquaculture. But when the land of low salinity are used for brakish water shrimp aquaculture, soil salinity increases. Though in shrimp-paddy pattern soil salinity is diluted in paddy culture time but net increment of salinity in soil is positive. If these lands are used for brakish water shrimp cultivation for several years, the cumulative increment of salinity in soil would be in a label when soil would become unusable for agricultural practices. On the other hand, due to saline water seepage soil salinity in adjacent land also increases.

Table - 3.4

Local people's opinion about increase of soil salinity in adjacent agricultural land of shrimp farm due to shrimp cultivation

Opinion	Cox's Bazar	Moheskhali	Teknaf	All
Yes	45 (45.0)	40 (40.4)	5 (5.0)	90 (30.0)
No	55 (55.5)	60 (60.0)	95 (95.0)	210 (70.0)

Source : Field Survey, 1991.
Note : Figure within parenthesis indicates percentage

The calculated value of χ^2 (Chi) of Table 3.4 is 146.2 with 2 d.f. which is greater than tabulated value at 1% level. So, the hypothesis is rejected and there is significant difference among the responses of local people from different pattern of shrimp cultivation. This table reveals that maximum numbers of people of Cox's Bazar think that soil salinity is increasing due to shrimp cultivation and in Teknaf, this kind of response is minimum.

Table - 3.5

Soil salinity of the coastal areas of Bangladesh

Name of regions	Total Area of regions Km^2	Area (km^2) by soil salinity class					
		2-4 mmhos/cm	4-8 mmhos/cm	8-15 mmhos/cm	>15 mmhos/cm	Total	% of region
Khulna	16891	37.07	1581.18	1522.34	297.31	3437.90	28.6
Barisal & Patuakhali	14360	12.16	865.24	2197.84	--	3215.24	27.5
Noakhali	5270	--	2351.55	370.93	--	1722.48	51.7
Chittagong	7222	16.33	299.91	718.53	352.27	1387.03	19.2
Total	43643	205.56	5096.07	4808.35	649.58	15946.86	29.7

Source : MPO, 1987, P. 2-12
*mmhos= Mili-mhos electrical conductivity.

From Table 3.5, it is seen that the coastal areas of Bangladesh have 15946.86 km^2 of saline land (soil salinity more than 2 mmhos/cm.) which is 29.7% Of the coastal area. Most of this land are suitable for brakish water aquaculture (except Noakhali area where elevation is not favourable for tidal inundation). If continuous extensive expansion is permitted, a vast amount of coastal land will be converted to shrimp farm and this will decrease agricultural production. Land with more than 15 mmhos/cm. of salinity have no agricultural potentials and with 8-15 mmhos/cm. of soil salinity produce only one agricultural crop (especially paddy) in rainy season and yield is very low. These lands can be efficiently used for shrimp farming and could achieve our national objects (earn Tk. 15,000 of foreign exchange ,FAO,1986). There are about 64958 hectares of land with more than 15 mmhos/cm. of soil salinity. IF 50% of this kind of land are suitable for tidal inundation, net cultivable land for brakish water aquaculture would be 32479 hectares which can produce 32479 metric Tons of shrimp per year according to the estimation of MPO, 1987, (1000 Kg/ha/yr) without feeding and with improved management, water control and exchange, nursery rearing and fertilization. This rate of yield (1000 Kg/ha/yr) have been realized in two semi-intensive farms of Cox's Bazar - Allawala Farms Ltd. and The Acquaculture Farm Ltd (field survey,1991) with some feeding and water management. At this rate, the total production will be 185% of the quantity exported in 1989/90 (table 1.1). If further increase of production need, the second

category of land with 8-15 mmhos/cm. of soil salinity can be used for shrimp cultivation. In this process salinity problem can be minimized.

3.5. Conclusion

From the above discussion, it can be said that the level of salinity in underground water, surface water and soil is increasing but this problem becomes acute due to uncompact construction of dyke and indiscriminate expansion of area under brakish water shrimp cultivation. This problem can be minimized if some kinds of permanent dikes are constructed and lands of high salinity are isolated for shrimp cultivation and the rest of the land are restricted for shrimp cultivation. Intensive type mono-culture of shrimp can be helpful in this respect because ,dykes and canal are constructed scientifically in this method. Only problem of this method is underground water discharge to dilute water salinity in March-April time when salinity level exceed the tolerance limit. If these months are excluded from shrimp cultivation calendar, the problem will be minimum.

CHAPTER FOUR

EFFECTS OF SHRIMP CULTIVATION ON SILTATION

4.1. Introduction

Siltation means gathering of silt. This occurs due to disturbance of normal flow of the river or canal. Shrimp cultivation needs to construct embankment and bund parallel to river or sea shore. Channel closures are required whenever the embankment crossed a river or khal. Drainage sluices are constructed to drain excess rain water from polders into adjacent channels. The construction of large numbers of sluices required on the closure of many tidal channel. As a result, rain water inside the polder can not flow freely and channel are blocked from siltation. This especially affects the fish of the area and also creates problems for communication as traditional navigation channels are blocked and decrease of fertility of agricultural land becomes evident because silts are not fine. On the other hand, blockage of drainage channel increases flood occurrence. When agricultural land are flooded with water, silt are gathered in the field which hamper crop production. Silt are not always fertile, sometimes it is pure sand which also decreases the fertility of the agricultural land. Figure 4.1 helps to understand how normal flow of water is hampered and silts gather due to construction of bund for shrimp cultivation. Effects of shrimp cultivation on siltation may be discussed in relation to siltation in shrimp farm itself which needs frequent clearance and increase cost of shrimp culture. Siltation in agricultural

field decreases fertility and siltation in river , canal and waterbody decreases fish breeding and growth and create navigation problem and flood occurrence.

4.2. Siltation in shrimp farms

Siltation or sedimentation in shrimp farm itself occur due to storage of tidal water with silt in shrimp pond. In time of water intake in the pond some sandy silts are entered with water and gathered in the bottom of the shrimp pond and water intake canal. This siltation depend on availability of sediment in tidal water which depend on the flow of sediment through river water from inland. In case where tidal water is permitted to enter in the shrimp pond directly, sedimentation is high and it is low where tidal water is reserved in the reservoir first and then entered in the pond . In case of semi-intensive culture, the later is a common practice.

Table - 4.1

Sedimentation in shrimp farms

Name of patterns	Amount (cm.)
Shrimp only	1.05
Shrimp-Salt	2.40
Shrimp-paddy	0.00

Source : Field Survey, 1991.

In general serious problems with respect to sedimentation in shrimp pond have not been observed, but this might be a matter of

time. In the long run, the elevation of the shrimp pond will increase which is expected to reduce tidal water supply. This kind of problem exists in shrimp only and shrimp-salt pattern. Shrimp-paddy pattern has no siltation problem in the farm because in paddy cultivation time, when rain water stock and flow alternatively to dilute salinity of the soil, gathered sediments are swept out. In the shrimp only and shrimp-salt pattern have not the scope of sweeping sediments.

The calculated values of t(Test-statistic) are 2.46, 7.34 and 3.17 between shrimp only and shrimp-salt pattern, shrimp-salt and shrimp-paddy pattern and shrimp-paddy and shrimp only pattern, respectively, with 18 d. f. for every cases at 1% level. All values of t are greater than tabulated value. So, there are significant difference in siltation among shrimp cultivation patterns.

4.3. Siltation in agricultural field

Siltation in agricultural field occur because flood water of agricultural field can not drain out smoothly due to construction of polder embankment. The embankment project changed the water flow system with closing of the mouth of many channel and construction of sluices. As a result drainage of water from the agriculture field become slow which enhance the silt gathering. Sedimentation also increases from erosion of earthen bund due to rainfall in monsoon season which are constructed for shrimp culture.

In most of the cases silts are sandy which decrease the fertility of soil and so reduces agricultural yield. In cases where sediments deposit on the field contain fine silt and clay fraction means increase nutrients and agricultural production can be increased. But only in Moheshkhali an increase of soil nutrients has been reported by the local people. In Cox's Bazar and Teknaf area, silts are mostly sandy because rivers in these areas originate from sandy hills and flow steadily with heavy current.

Table - 4.2

Local people's Opinion about siltation in agricultural field due to shrimp cultivation

Opinion	Cox's Bazar	Moheshkhali	Teknaf	All
Yes	4 (4.0)	36 (36.0)	0 (0.0)	40 (13.3)
No	86 (86.0)	64 (64.0)	100 (100.0)	250 (83.3)
No response	10 (10.0)	0 (0.0)	0 (0.0)	10 (3.3)

Sources : Field Survey, 1991.

Note : Figure within parenthesis indicates percentage

Table 4.2 reveals that in Moheshkhali where shrimp-salt pattern are practiced has maximum siltation in agricultural field. In

Moheshkhali Thana, 36% people think that silts gather in agricultural field but this does not create acute problem because in this area silts are not sandy. In Cox's Bazar where shrimp only pattern are practiced has less siltation problem. Only 4% people of this area think that silts gather in the agricultural land due to shrimp cultivation. In Teknaf, where shrimp-paddy pattern is practiced, no people think that silts gather in agricultural field. This is because, over flow of saline water from shrimp pond is very uncommon in Teknaf area.

The calculated value of χ^2 (Chi) is 43.62 with 2 d. f. which is greater than tabulated value at 1% level. So there are difference among responses in different areas of shrimp cultivation.

Table - 4.3

Local people's opinion about siltation in river and waterbody due to shrimp cultivation

Place	Cox's Bazar	Moheshkhali	Teknaf	All
River	0.0% (0)	31.3% (10)	0.0% (0)	24.4% (10)
Canal & Khal	100.0% (9)	56.3% (18)	0.0% (0)	65.9% (27)
Pond	0.0% (0)	12.7% (4)	0.0% (0)	9.8% (4)

Source : Field Survey, 1991.

* Figure within parenthesis are the number of responses

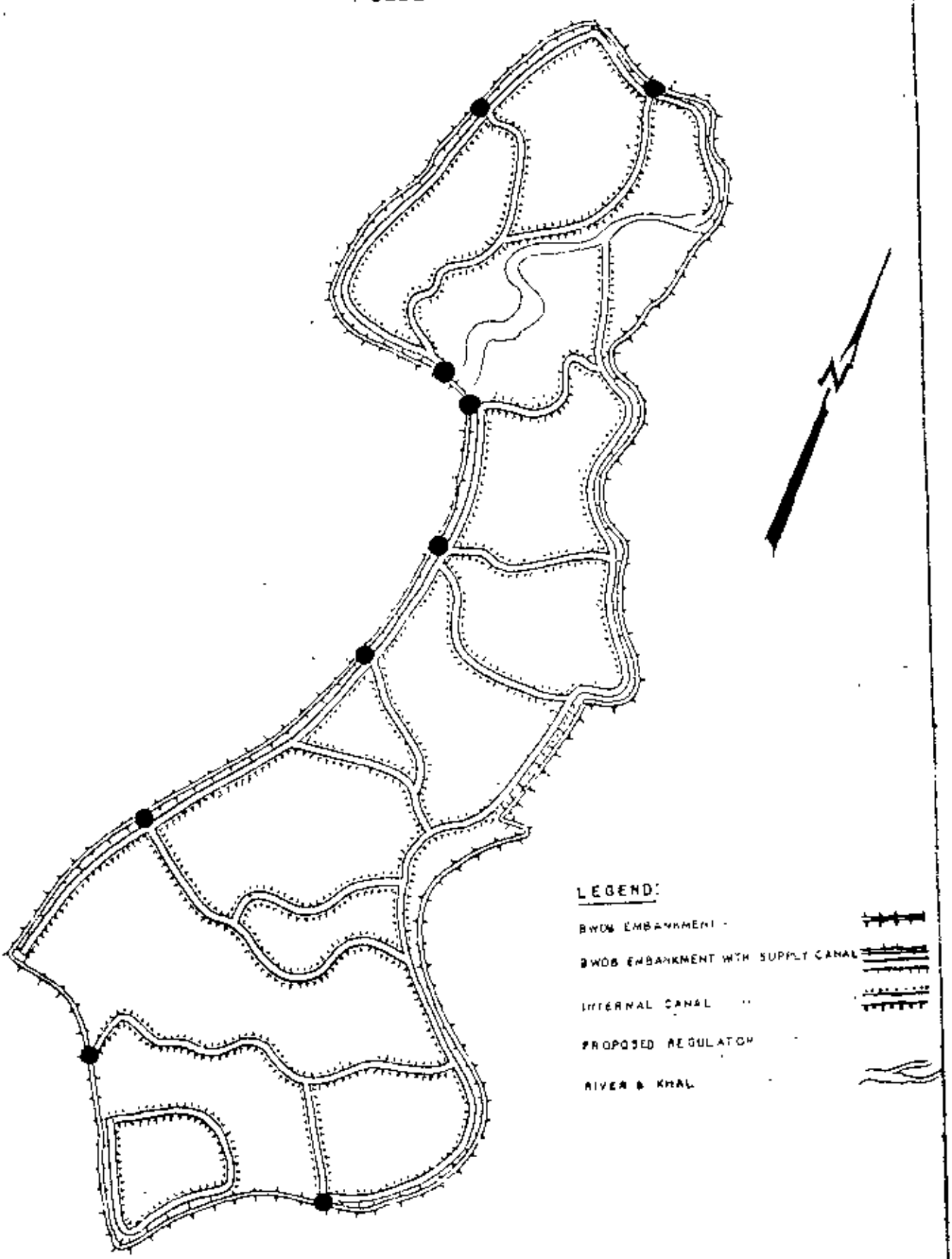
4.4. Siltation in river and waterbodies

After the construction of BWDB polder to control tidal water intrusion and protect marshy land, which are used for shrimp cultivation from tidal natural flooding, a new situation was created with respect to sedimentation and erosion, Originally the coastal rivers, creeks and canals were silted and drained twice a day with tidal water. As a result, the creek and canal system was not stable and continuously subject to changes caused by sedimentation and erosion as one section silted up and another section eroded.

After the construction of polders, a new water management system is created inside the embankment in which excess rain water could be drained during monsoon period via sluice. So sediment containing river water from sea or rainfall enter inside the embankment but silts are not cleared when excess water are drained out through outlet. As a result, creeks and canal inside embankment are silted up. The course materials settles near the inlet while the finer parts settle further away.

In addition to this in time of embankment construction many creeks and canal are filled by earth to reduce the number of sluice which hamper the normal flow of river water and these sedimentation increases. Moreover, earthen bund erosion is very common in time of tidal insurgence and fill the river, creeks and canal.

MAP NO. 4.1: SHRIMP CULTURE PROJECT (IDA)
POLDER NO. 66/4



Source : BWDB, 1985, P.V-6

Table 4.3 shows that siltation in river is not a problem in Cox's Bazar and Teknaf Thana. In Moheshkhali Thana 31.3% people think that silts gather in the rivers. Cent percent people of Cox's Bazar think that silts gather in the canal and khal and in Moheshkhali Thana 56.3% people think it. No people of Teknaf think that there is any siltation problem in canal & Khal or pond. So, it can be remarked that siltation problem in canal & khal in Cox"s Bazar Thana is very high. This occurs because in Cox's Bazar, tidal saline water are reserved in canal and khal, before entering into the shrimp farm and silts fall to the bottom of the canals & khals. In Moheshkhali siltation occur more or less in everywhere in river, canals & khals and ponds because there is no reserving system before entering saline water in the shrimp pond. Teknaf Thana has no siltation problem anywhere because in this area shrimp are cultivated in dry season when tidal water contain very less amount of silts.

The calculated value of χ^2 (Chi) is 38 with 2 d. f. which is greater than tabulated value at 1% level. So there are difference among responses in different areas of shrimp cultivation.

4.5. Conclusion

As shrimp culture has been introduced recently, the effects of these processes may not be noticed for sometimes but there is no doubt that shrimp culture intesifies sedimentation.

From above discussion it can be concluded that sedimentation associated with shrimp culture is not the same in different pattern of shrimp cultivation. Shrimp-paddy pattern appears to have no siltation problem but shrimp only pattern has highest siltation problem in canal & khal and in shrimp-salt pattern silts are gathered in river, canal and agricultural field moderately. It can be important to mention here that shrimp cultivation has a number of negative effects associated with siltation but use of proper water management technique, proper construction of embankment and bund and provision of adequate number of outlet and sluice can reduce sedimentation problems considerably.

CHAPTER FIVE

EFFECTS OF SHRIMP CULTIVATION ON VEGETATION

5.1. Introduction

In polder areas many types of vegetation occur. On the farmyard often coconut trees and other fruit trees are grown which contribute either to the food supply or to the income of the people. Apart from these fruit trees, a large number of other trees and bushes grow, which are important as shelter against the sun, as fuel for cooking, and as food for livestock. Trees are also very important for local ecosystem.

Before starting shrimp farming, land are cleared if there are any bushes or forest. On the other hand, once shrimp cultivation has started, trees and vegetation may be disappeared due to excess salinity and inundation. In the farm areas, most of the trees and vegetation are completely cleared. Sometimes trees on the bund and embankment are excluded but due to seepage and leakage of saline water these trees disappear subsequently. Vegetation outside of the shrimp farm also disappear due to saline water seepage.

In the polder areas, many types of vegetation occur - all are not equally susceptible to salinity condition. Coconut trees, Date palm, Palm trees etc. can grow and exist in more saline soil. Other type of vegetation like Guam, Challa, Sheora, Nal khagra, Dal ghas etc. can grow in saline swampy areas.

Effects of shrimp cultivation on vegetation are discussed in the following section.

5.2. Direct Effects

Direct effects of shrimp cultivation on vegetation are vegetation clearance for shrimp farm preparation, vegetation disappears due to salinity inclusion and decrease in pasture land due to inundation and salinity.

Shrimp cultivation is a land development process in which normally swampy forest land or agricultural land of low elevation are converted into shrimp pond by embankment construction. In case of swampy forest or bushy land, at first trees and bushes are cleared totally or except trees on the land where bund and embankment would be constructed. Table 5.1 shows the percentage of forest land and pasture which have been converted to shrimp pond clearing forest and pasture.

Table - 5.1

Percentage of different type of land converted to shrimp farm by Thanas

Type of former land use	Cox's Bazar (%)	Moheshkhali (%)	Teknaf (%)	Total (%)
Forest	7.7	0.0	0.0	2.4
Agriculture	0.0	20.0	0.0	7.3
Pasture	0.0	26.7	30.8	19.5
Marsh land	38.5	6.7	23.1	22.0
Salt Bed	15.4	40.0	0.0	19.5
Paddy field	38.5	6.7	46.2	29.3

Sources : Field survey, 1991.

Disappearance of trees in adjacent areas of shrimp field occur due to saline water entrance and saline water seepage. Table 5.2 shows the decrease of farmyard vegetation of nearby village of shrimp production project areas from which we can see that a considerable amount of farmyard vegetation has decreased but all type of vegetation were not affected equally.

Table - 5.2

Percentage changes of common vegetation in sample household from 1981 (base=100) to 1991.

Name of the trees	Cox's Bazer (%)	Moheshkhali (%)	Teknaf (%)	Total (%)
Mango	56	67	---	60
Black berry	70	81	---	78
Jack fruit	93	79	112	92
Guava	66	58	---	69
Jujube	196	85	201	154
Shimul	131	84	146	122
Madar	171	69	78	102
Sonalu	118	54	---	86
Badi	---	115	---	115
Thersol	86	136	---	129
Rain tree	---	103	150	104
Date tree	61	87	---	78
Coconut	115	110	115	113
Bamboo	98	68	90	81

Sources : Field Survey, 1991.

From Table 5.2, it can be seen that disappearance of vegetation is highest in shrimp only pattern. In shrimp-salt pattern,it is high but lower to shrimp only pattern and shrimp-paddy pattern affects vegetation slightly. It can be noted here that number of trees of jujube, coconut, Madar etc. have incressed in shrimp

cultivation regions. It is reported that these trees can tolerate higher level of soil and water salinity. In the respect of vegetation disappearance, local people's view is more aggressive to shrimp-salt pattern than only shrimp pattern. Table 5.3 reveals that 10% people of Cox's Bazar think that vegetation is disappearing whereas in Moheskhali 26% local people think that. The local people of Teknaf do not think that vegetation is disappearing due to shrimp cultivation.

The calculated value of χ^2 (Chi) is 42.96 for the yes responses of the table 5.3 with 2 d.f. which is greater than tabulated value. So it can be concluded that there is significant difference among responses from different shrimp cultivation regions.

Table -5.3

Local people's view about disappearance of vegetation due to shrimp cultivation

Opinion	Cox's Bazar	Moheshkhali	Teknaf	All
Yes	10 (10.0)	26 (26.0)	0 (0.0)	36 (12.0)
No	40 (40.0)	53 (53.0)	60 (60.0)	153 (51.0)
no response	50 (50.0)	21 (21.0)	40 (40.0)	111 (37.0)

Sources : Field Survey, 1991.
Note : Figure within parenthesis indicates percentage

5.3. Indirect Effects

In addition to its effects on vegetation clearance, decrease of

pasture land and disappearance of trees, shrimp culture have some indirect effects on vegetation. Formerly, when land under shrimp culture are used as agricultural practices, agricultural residuals were used as fuel for cooking and as food for livestock and cow dung further used as fuel and manure. Now food crises for livestock has decrease number of livestock (Table 5.4). As a result fuel crisis become acute in this region which enhance deforestation of hilly forest of the region. Fuel wood collection from hill has become a common and profitable business which decrease upstream vegetation and increase soil erosion and sedimentation in the river and agricultural field and creates problem in local ecosystem. Non- availability of cow dung manure decrease the organic matter and fertility of soil of agricultural land and garden prevent the scope for further growth of vegetation and decrease agricultural yield.

Table -5.4
Percentage changes of livestock in sample household from 1981(base=100) to 1991.

Name of the Livestock	Cox's Bazar (%)	Moheskhali (%)	Teknaf (%)	Total (%)
Cow	66	45	55	53
Buffalo	61	75	87	75
Goat	225	53	NA*	93
Duck	110	121	NA	118
Fowl	79	70	99	81

Sources : Field survey, 1991.
* Data not available.

5.4. Conclusion

From above discussion it may be concluded that the three patterns of shrimp cultivation have differential effects on vegetation. Shrimp-salt pattern has the highest effects. Shrimp only pattern has moderate effects and shrimp-paddy pattern has very little effects on vegetation.

It is true that effects of shrimp cultivation on vegetation become harmful especially for local ecosystem but these effects can be minimized by taking some appropriate measures. Some trees can easily grow on the bund and embankment of shrimp pond to increase vegetation. Local people know that coconut trees can grown on the bunds of shrimp pond but they do not plant because bunds of their field are not permanent. If planned bund and embankment are made, this is possible. One thing worth mentioning is that plant produce taxied or acidic fruit are not suitable for plantation because it is very harmful for shrimp's livelihood and growth.

CHAPTER SIX

CONCLUSION AND RECOMMENDATION

6.1. Conclusion

Shrimp cultivation has become an important economic activities in coastal areas of Bangladesh. Due to higher economic return and international demand, it is expanding rapidly. But shrimp cultivation has brought some negative impacts on environment. These impacts are, viz., increase of salinity in soil and water, decrease of vegetation due to disappearance of trees and reclamation of forest and siltation in lands and waterbodies etc. Studies so far undertaken have discussed these impacts in a general manner. The purpose of this study is to analyze the impacts of shrimp cultivation on environment by the types of farming as practiced in the coastal areas.

Bangladesh has three traditional patterns - shrimp only, shrimp-salt and shrimp-paddy and one semi-intensive shrimp only pattern of shrimp cultivation. To study environmental impacts of all of these patterns, Cox's Bazar district was selected as the study area where all patterns of shrimp cultivation are available. Among the Thanas of Cox's Bazar district, Cox' Bazar Thana was selected for shrimp only pattern, Moheskhali Thana was selected for shrimp-salt pattern and Teknaf Thana was selected for shrimp-paddy pattern.

From the study it was found that whereas shrimp only traditional pattern contributes to the increase salinity of water and soil at

higher rates, it causes little siltation in shrimp farm land, moderates siltation in agricultural field and high siltation in water bodies. This pattern also leads to disappearance of trees and decrease of fodder for animal and bio-mas for fuel at a high rate.

The shrimp -salt pattern contributes to increase of salinity in water and soil and increase of siltation in farm and agricultural land at a high rate. Siltation in water bodies is found at a lower rate in shrimp-salt pattern. This pattern leads to decrease of vegetation, fodder for livestock and bio-mas for fuel at a high rate.

The shrimp-paddy traditional pattern contributes to increase water and soil salinity and siltation in farm and agricultural land at a negligible rate. It was found that shrimp-paddy pattern leads to decrease of vegetation, fodder and bio-mas at a considerable rate but the rate low when compared with other patterns.

It was also found that the semi-intensive shrimp only pattern leads to the increase of salinity of water and decrease of vegetation at a high rate but it contributes to the increase of siltation in farm and agriculture at a low rate.

These environmental effects due to different shrimp cultivation patterns can be summarized in the following form of a table with the help of Environmental Impacts Assessment (EIA) approach. The methodologies of EIA discussed in appendix-C.

Table 6.1 : Environmental Impact Assesment of Shrimp Cultivation Projects

	Name of Projects	1. Salinity				2. Siltation				3. Vegetation					Frequency					Net Impact
		Underground Water Salinity	Surface Water Salinity	Soil Salinity		Siltation in Shrimp farm	Siltation in Agricultural Field	Siltation in Water body		Disappearance of Trees	Shortage of Fodder	Shortage of Fual	Vegetation reclamation		Very High (5)	High (4)	Moderate (3)	Low (2)	Very Low	
Traditional	Shrimp Only	VH	H	H		L	M	H		H	H	VH	L		2	5	1	2	0	37
	Shrimp Salt	H	H	H		H	H	M		M	VH	VH	VH		3	5	2	0	0	41
	Shrimp Paddy	VL	H	VL		VL	VL	L		L	L	L	H		0	2	0	4	4	20
Semi Intensive	Shrimp Only	VH	H	H		VL	VL	H		H	H	VH	L		2	5	0	1	2	34

Note :

VH = Very High
H = High
M = Moderate
L = Low
VL = Very Low

Score :

Very High = 5
High = 4
Moderate = 3
Low = 2
Very Low = 1

The Table 6.1 reveals that shrimp-paddy traditional pattern contributes to environmental deterioration at a low rate and shrimp-salt traditional pattern contributes at a high rate. Enviromental deterioration from shrimp only pattern is moderate in both traditional and semi-intensive methods. This pattern of environmental impacts of shrimp cultivation can be compared with the economics of farming.

The net revenue obtained from different patterns vary substantially (Appendix - D) of which semi-intensive pattern gives highest net return among the different type of shrimp cultivation practiced in Bangladesh.

In case of employment semi-intensive pattern needs more human labour than any other type of shrimp cultivation and shrimp/ rice traditional pattern also is in the second.

From the above discussion, the following recommendations have been formulated :

6.2. Recommendation

1) Net negative impacts of shrimp cultivation on environment is lowest in shrimp paddy pattern but yield is low in this pattern. On the other hand, semi-intensive shrimp only pattern yields higher than any other traditional pattern. Although semi-intensive pattern has a considerable amount of negative effects on environment but takes small amount of land for achieving

target production. So, total impacts on environment will be low. For this reason, semi-intensive pattern of shrimp cultivation should be encouraged. In this direction, Government policy should be formulated. If it is not possible due to capital shortage, shrimp-paddy pattern can be chosen to minimize environmental impacts.

2) In areas where conflicts between land uses do not arise because of poor soil condition, lack of fresh water for irrigation or sparsely populated area should be encouraged for shrimp cultivation and in the areas where two crops of rice or other agricultural product can be grown having adequate fresh water for irrigation, shrimp farming should be discouraged. To do this first priority land for shrimp aquaculture will have to be isolated. Lands with salinity of more than 15 milli-mhos/cm. should be used at first. If additional land is required, then land with lower salinity can be used for shrimp cultivation.

3) For the construction of permanent embankment and sluice , engineering and monetary aid should be provided through government agencies to the farmers. It can help to minimize the environmental effects reducing seepage of saline water and soil erosion of embankment.

4) In Bangladesh shrimp juvenile are collected from river estuaries when other type of plankton are trapped and they are left in the bank of the river and sea shore. It may decrease our

natural stock. So steps should be taken up to regulate the esturine capture by imposing some restrictions. Before doing this adequate number of shrimp juvenile production hatchery should be established.

5) As the HNAQUA GROUP , a distinguished professional shrimp farming organization comment that minimum of 3.5 metric tons/ha/crop of shrimp production is easily achievable in ideal site location and using 'state of art ' technologies (Mahmood 1088). So intensive type of shrimp farming should be encouraged in lue of shrimp area expansion to achieve more production.

6) An EIA (Environmental Impact Assessment) should be mandated for all shrimp cultivation project at the first step of planning. A small Authority under planning commission or under the Ministry of Forest and Environment should be established to do this.

7) Khas land suitable for shrimp cultivation are often leased out by the Government to the shrimp farmer but considerable amount of these land have leased out to absentee farmers who rent out the lands to a third party which hamper efficient management of shrimp land and create more environmental problems. This has to be stopped.

8) Shrimp farming requires a sound technical knowledge and huge amount of capital. Some plots may be leased out to those shrimp farmer who can established model farm to show the technical know

how in the vicinity and Bank and other financial agencies should extend loan facilities on easy terms and condition to help the vertical expansion of shrimp cultivation.

9) Risk is another limiting factor in favor of intensive shrimp farming . Government agencies should share the risk and to do this insurance system for shrimp cultivation needs to developed.

10) Electricity supply in the shrimp farm and supply supplementary feed to growing stock help quality pond management and increase production respectively. In favor of this Government steps are necessary.

11) To minimize the effects of shrimp cultivation on salinity, the period when tidal water contain highest salinity should be excluded from shrimp culture calendar. Thus May-September and October- February can be two shrimp cultivation seasons. Artificial supply of adequate shrimp juvenile can make it possible because highest natural juvenile available in February-March and these months are not considering as stocking period in suggested shrimp cultivation calendar.

12) Afforestation of the embankments of shrimp project can help to decrease the effects of shrimp cultivation on vegetation and mangrova forest should be totally restricted against shrimp culture conversion.

13) Beheading of shrimp in farm label should be discouraged

because it often decreases the quality of shrimp and price. In addition to this, detached head of shrimp are left anywhere thus creating environmental pollution.

14) During the year 1984/85, the total quantity of discards of heads and other waste of shrimp amounted to 2528 metric Tons (Das, 1989). These cards are mostly thrown into the rivers and khals through the year by deheading centers and farmers. It polluted the Environment. So, a research program should be carried out to examine whether it is possible to use detached head of shrimp as a raw material for shrimp feed producing industry.

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APPENDIX - A

QUESTIONNAIRE FOR HOUSEHOLD SURVEY

Date:

1. Address:

   a) Name of the respondent :

   b) Village/Mouza :

   c) Union :

   d) Upazila :

2. Land ownership :

   a) Non-crop land :

      i) Homestead :

      ii) Waterbody :

      iii) Garden :

   b) Crop land :

      i) Owned land :

      ii) Rented in :

      iii) Rented out :

3. Characteristics of household members :

Sl. No.	1	2	3	4	5	6	7	8	9	10
Age										
Sex										
Education										
Occupation										

Code :

Sex :	Education :	Occupation :
1. Male	1. Illiterate	1. Agriculture
2. Female	2. Primary	2. Day Labour
	3. Secondary	3. Shrimp Cultivation
	4. Higher Secondary	4. Service
	5. Graduate	5. Business
	6. Post Graduate	6. Industry
		7. Student

4. Cost and return of paddy cultivation

a) Return :

	Amount of Land (acres)	Amount of production (mnds)
Aus		
Aman		
Boro		

b) Costs :

	Labour (man days)	seed (Srs)	fertilizer (srs.)	water (Tk.)	insecticide (Tk.)	others (Tk.)
Aus						
Aman						
Boro						

5. Income of the family :

a)From agriculture (Tk.) :

b) From non-agriculture (Tk.) :

6. Livestock of the Family (number) :

	1991	1981
a) Cow		
b) Buffalo		
c) Goat/Sheep		
d) Chicken		
e) Duck		

7. Opinion about shrimp cultivation :

a) Are you benefited from shrimp cultivation ? yes No

b) If yes, then How ? 1) Increase of income
2) Increase of employment
3) Others

c) Are you a looser from shrimp cultivation ? yes no

d) If yes, then How ? 1) Drainage problem
2) Flood problem
3) land leased by force
4) salinity problem
5) Others

8. Response about Siltation :

a) Does shrimp cultivation create siltation problem ? yes no

b) If yes, then Where ? 1) River
2) canal and khal
3) Fresh water pond
5) Crop land
6) others

9) Response about Salinity :

a) Does salinity increase in underground water due to shrimp cultivation ? yes no

b) If yes, then how much ? 1) Very high
2) high
3) Moderate
4) Less
5) very less

c) Is salinity increase in the following? (tick one or both if yes)

1) Surface water
2) Soil

10) Questions about vegetation :

a) What are the number of trees in your homestead ?

Name of the trees	Numbers in 1991	Numbers in 1981
Mango		
Black berry		
Jack fruit		
Guava		
Jujube		
Shimul		
Mader		
Sonalu		
Badi		
Thersal		
Rain tree		
Palm		
Date palm		
Coconut		
Bamboo		
Others		

b) Do you think that trees are disappearing due to shrimp cultivation ? yes no

Questionnaire For Farm Survey

Date :

1. Name and address of the respondant :

   a) Name :

   b) Village/Mouza : c) Upazila:

2. general information about the farm

   a) How many years you are cultivating shrimp in the farm ?

   b) What are the former use of the farm land before shrimp cultivation ?

      i) Forest

      ii) Agriculture

      iii) Pasture

      iv) Marsh land

      v) Salt beds

      vi) Fish cultivation

      Vii) Paddy cultivation
      viii) Others

   c) What is the area of the farms ? acres ----

3.Returns from shrimp farm :

   a) Production of shrimp (kg) -------

   b) Production of salt (mnds) -------

   c) Production of paddy (mnds) ------

4. Costs for shrimp farm :

   a) Costs of shrimp production (Tk.)

Capital costs	Operating & Maintenance

   b) Costs of salt production (Tk.)

Capital costs	Operating & Maintanance

c) Costs of paddy production (Tk.)

capital costs	Operating & Maintenance

5. What amount of silts gathered in your farm per year ? (cm.)

_____

6. Give the monthly highest level of salinity in your shrimp farm water (if any).

January ____ February _____ March _____

April ____ May _____ June _____

July ____ August _____ September ___

October ____ November _____ December ___

7. Is there any trees in ypur farm ? Yes No

8. If yes, then What kind and hpw many ?

Kinds	Numbers
Coconut	
Other fruits	
Trees for wood	

9. Do you think that plantation is possible on the bunds of shrimp ? Yes No

10. If yes, than what kinds ? (Tick any)

Coconut Other fruits Trees for wood

APPENDIX - B

Institutional setup involve in shrimp culture

Ministry	Institution	Activities
Ministry of Fisheries and Livestock	Directorate of Fisheries	Administrative, Management development, Extention and Training
	Bangladesh Fisheries Development Corporation	Training, Production and
	Fisheries Research Institute	Research and Training
Local Government, Rural Development and Cooperative	Rural Development Board	Fishery Component of Integrated Rural Development
	Directorate of Cooperatives	Registration and Supervision of Fisheries Cooperatives
	Bangladesh Jatio Matshyajibi Samabaya Samity Ltd.	Development of Fisheries Cooperatives. Operation of Ice Plant and Import of gear
	Bangladesh Samabaya Bank Ltd.	Financing Fishermen Cooperatives
	Upazilla Administration	Management of water bodies less than 20 ha.
Ministry of Land	Land Administration and Land Reform Division	Leasing of Public water bodies
Ministry of Irrigation, Water Management and Flood Control	Bangladesh Water Development Board	Leasing of Reservoir and Irrigation Cannals
Ministry of Commarce	Department of Commarce	Leasing of Fish Processing Plant
	Export Promotion Bureau	Export Promotion of Shrimp, Fish and Fish Products

(Contd.)

Ministry	Institution	Activities
Ministry of Industry	Bangladesh Sugar and Food Industries Corporation	Processing of Shrimp and Fish
Ministry of Shipping	Marcantile Marin Department	Registration of Fishing Boat
Ministry of Education	Universities	Higher Fisheries Education
Ministry of Planning	Fisheries Section	Planning and Overall Coordination of all development activities on Fisheries
Ministry of Foreign Affairs		Exclusive Economic Zone Negotiation

Source: Karim (1988) Rahman (1989) Quated in Hassan (1990)

APPENDIX-C

Method of Environmental Impact Assessment:

The process for environmental assessment in both an art and science. There are no universally applicable procedure for assigning inputs of any action and activity. Any evaluation process is the product of numerous combination of objective and subjective factors. Total objectivity is impossible, and it is informed subjectivity which often contributes most to the success of an evaluation efforts. The methodology described below is simple, cost effective and permits any number of environmental factors to enter the evaluation process. As a result, it can be made suitable for assessing secondary impact of a project. After deleting and adding relevant factors, it can be adopted to allow simultaneous assignment of several projects in one formate. It permits the considerations of the impacts of project alternatives on the environment in a comparable way.

1.1 The Environmental Impact Assessment (EIA) process involves the imposition of a project on the original environment and the estimation of the resultant changes. Depending on the extent of the changes and their significance, rating are assigned to the factors using of the impact gauging scale. The same process is repeated for the alternative projects. Then total scores are determined summing up the rating assigned. The total scores provide a basis for determining the impact on the environment of the projects and alternatives.

d) **Assessment of the changes and rating:**

The intensity of negative impact are compared in the following steps and rating are made on the basis of comparisons of the measurement of the impact or other statistical method.

The rating may be:

Very High (VH)
High (H)
Moderate (M)
Low (L)
Very Low (VL)

e) **Imposition of scores for the rating:**

Imposition of score may be positive or negative. If only negative impact are assessed, positive score may be imposed for all ratings otherwise it is better to impose positive score for positive impact and negative score for negative impact.

The scores may be:

Very High - 5
High - 4
Moderate - 3
Low - 2
Very Low - 1

1.2 Steps of the Environmental Impact Assessment:

a) Selection of the environmental factors:

In this step the environmental factors which may be affected due to project are selected. In shrimp cultivation project, this factors may be the increase of salinity in ground and surface water, siltation in waterbodies and land, decrease of navigation etc.

b) Assessment of the original condition of the environment in terms of selecting factors:

In project area, the salinity level of water in original condition can be measured ppt (parts per thousand) in particular time of the year or in average of the year, siltation may be measured by cm per year etc.

c) Assessment of the changes due to projects:

If the salinity level increase after project, this a negative change. If any positive change occurs it also may be included in the evaluation process.

f) Calculation of total scores: Total scores are calculated by the summation of scores of different categories. Scores of different categories are calculated by multiplying the total number of that category by score of the respective category.

g) Conclusion: Conclusion can be drawn on the basis of the total score of the individual projects. The projects have higher score indicate that it has higher adverse impact on environment.

The above procedure can be summarized in the following matrix. The net impact derived from the matrix can give an idea of the overall impact of projects. Further it offers an important means of comparing alternatives, and of selecting the option least harmful to the environment. one of it major shortcomings is that it uses equal-weight principle in factors evaluation.

Project alternatives	Environmental factors (rating)						Frequency (number)					Net impact
	Soli-nity		Silt-ation		Vege-tation		VH	H	M	L	VL	Summation of frequency multiplied by respective score
Name of the project/ projects	VH		L		H							

APPENDIX-D

Table - D.1

Average annual costs and net returns from Brakish water Shrimp Cultivation modes at market price. (1991 Tk/Ha).

Modes	Gross Return	Costs			Net Returns
		Capital	O & M	Total	
Traditional					
Shrimp only	43,445	1,947	28,948	30,895	12,555
Shrimp-salt	35,050	1,263	25,540	26,803	8,247
Shrimp-paddy	50,000	1,392	29,446	30,838	19,162
Semi-Intensive					
Shrimp only	200,000	20,000	110,000	130,000	70,000

Source: Field Survey, 1991.

Table - D.2

Financial comparison of shrimp culture modes of development At 1983 market price (80 Ha farm).

Modes	IRR (%)	B/C ratio	NPV (in '000 Tk.)
Traditional			
Shrimp only	NNC*	4.00	5,284
Shrimp-salt	NNC	2.50	3,226
Shrimp-paddy	NNC	5.60	9,285
Semi-Intensive			
Shrimp only	119	8.30	17,409

Source: MPO, 1987, P. 4-7.

* No negative cash flow.