**PEOPLE'S REPUBLIC OF BANGLADESH**

Ministry of Irrigation, Water Development and Flood Control

Bangladesh Water Development Board



# CYCLONE PROTECTION PROJECT II - FAP 7
# FEASIBILITY AND DESIGN STUDIES



## FINAL PROJECT PREPARATION REPORT
## APPENDIX J - FISHERIES



May 1992

Joint Venture of
KAMPSAX INTERNATIONAL A/S,
BCEOM
DANISH HYDRAULIC INSTITUTE
in association with
DEVELOPMENT DESIGN CONSULTANTS LTD

Financed by European Community - Project No. ALA/87/05

2

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The present Report Volume is part of the

**CYCLONE PROTECTION PROJECT II - FAP 7**
**FEASIBILITY AND DESIGN STUDIES**
**BWDB COMPONENT**
**FINAL PROJECT PREPARATION REPORT**

Consisting of the following Volumes :

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# GLOSSARY

| | | |
|---|---|---|
| Aquaculture | - | Artificial and commercial cultivation of aquatic products (for example, growing shrimp in shrimp ponds). |
| Artisanal | - | Small-scale (for example, artisanal marine fishery). |
| Baor | - | Oxbow lake; a closed body of water, isolated from the river by a change in its course. |
| Beel | - | Small lake, low-lying depression, a permanent body of water in a floodplain or a body of water created by rains or floods that may not dry up in the dry season. |
| Derelict ponds | - | Ponds not suitable for culturing fish without improvements. |
| Fingerlings | - | Juvenile fish larger than fry (>2.5 cm). |
| Floodplain | - | Annually flooded, low-lying area associated with rivers. |
| Fry | - | Juvenile fish larger than hatchlings but smaller than fingerlings (1.5 - 2.5 cm). |
| Hatchery | - | Fish seed farm for spawning and hatching. |
| Nursery | - | Pond(s) where hatchlings are grown to fingerlings. |
| Polder | - | Area of low-lying land reclaimed from the sea by construction of a perimeter dike. |
| Post larvae | - | Young shrimp stage used for stocking ponds. |
| Upazila | - | Subdistrict, an administrative unit between zila and Thana. |
| Water | - | Water with a salinity level of 0 ppt is fresh water; of 0-30 ppt is brackish water; and greater than 30 ppt is marine water. |

# ABBREVIATIONS

| | | |
|---|---|---|
| ASR | = | Agriculture Sector Review |
| BBS | = | Bangladesh Bureau of Statistics |
| BWDB | = | Bangladesh Water Development Board |
| DoF | = | Department of Fisheries |
| EEZ | = | Exclusive Economic Zone |
| HYV | = | High Yielding Variety |
| IDA | = | International Development Association |
| MPO | = | Master Plan Organization |
| SPARRSO | = | Space Research and Remote Sensing Organization |
| UFO | = | Upazila Fisheries Officer |
| UNDP | = | United Nations Development Programme |

# 1. INTRODUCTION

## 1.1 General

The present report is Appendix J to the Preparation Report prepared as conclusion of the feasibility study conducted under Cyclone Protection Project II.

The report describes fisheries in the coastal areas covered by the project and concludes on the impact of the rehabilitation and strengthening of embankments on the fisheries.

Main findings and conclusions are presented in outline from in the Main Report.

## 1.2 Macroeconomic Contribution

Fisheries subsector contributes 3.5 per cent of the country's GDP (World Bank 1991). Within the agriculture sector, fisheries accounts for about 10 per cent of the gross value added. The subsector contributes about 80 per cent to the nation's animal protein intake. There are over 1.2 million commercial fishermen; out of which 60 per cent are in inland fisheries and 40 per cent in marine fisheries. Around 9.5 million households or about 64 per cent of all the households in Bangladesh get involved in the seasonal or part-time fishing in floodplains during the monsoon months. The share of fisheries in the total export earnings is about 12 per cent and currently occupies the third highest position after jute and readymade garments.

## 1.3 Fisheries Resources and Production

Bangladesh has extensive water resources within her boundaries and the territorial and economic zones in the Bay of Bengal. The water resources - are broadly divided into inland and marine resources. In 1987-88, the area of inland fisheries totaled 4.3 million ha, of which 94 per cent was open water capture areas (which accounted for 71 per cent of inland fish production) and the remaining 6 per cent was closed water culture fisheries (29 per cent of inland fish production). In case of marine fisheries, Bangladesh has a coastal belt of 480 km. Fishing area is estimated to be 14,000 km2. Marine fish catch is divided into industrial and artisanal. The artisanal fishery extends upto a depth of 40m in the Bay and harvests more than 95 per cent of the total marine landings (Table 1).

| Type of fishery | Production (mt) | Area (ha) | Yield (kg/ha) | Share In Production(%) | |
|---|---|---|---|---|---|
| | | | | Inland | Total |
| Inland capture | | | | | |
| River and estuaries[b/] | 191,883 | 1,031,563 | 186 | 32.0 | 23.2 |
| Floodlands | 182,037 | 2,832,792 | 64 | 30.4 | 22.0 |
| Beels[c/] | 45,610 | 114,161 | 399 | 7.6 | 5.5 |
| Kaptai Lake | 4,068 | 68,800 | 59 | 0.7 | 0.5 |
| Subtotal | 423,598 | 4,047,316 | 105 | 70.7 | 51.2 |
| Inland capture | | | | | |
| Ponds | 149,423 | 146,890 | 1,017 | 24.9 | 18.1 |
| Baors | 1,254 | 5,488 | 228 | 0.2 | 0.1 |
| Shrimp farms[d/] | 25,248 | 94,010 | 269 | 4.2 | 3.1 |
| Subtotal | 175,925 | 246,388 | 714 | 29.3 | 21.3 |
| Marine[e/] | | | | | |
| Industrial | 10,395 | f/ | f/ | 0.0 | 1.3 |
| Artisanal | 217,187 | | | 0.0 | 26.2 |
| Subtotal | 227,582 | - | - | 0.0 | 27.5 |
| Inland total | 599,523 | 4,293,704 | 140 | 100.0 | 72.5 |
| Marine total | 227,582 | - | - | 0.0 | 27.5 |
| Bangladesh total[g/] | 827,105 | 4,293,704 | - | 100.0 | 100.0 |

Table 1 : Estimated Production, Area, and Average Yield by Type of Fishery During 1987/88[a/]

Sources : World Bank (1991).

a/ Based on information obtained from the Department of Fisheries. 1987/88 was the latest year for which actual data was available.

b/ Include Sunderban. During 1987/88, fish production from Sunderban was 8,066 mt.

c/ Including haors.

d/ Coastal aquaculture. Production includes both fin fish (about one-third) and head-on-shrimp (about two-thirds).

e/ Fishing area is estimated to be 14,000 km2, which is about 22% of Exclusive Economic Zone (EEZ).

f/ Fishing area; hence, yields cannot be defined.

g/ During 1988/89, total fish production was 840,926 mt and area was 4,307,974 ha. An increase in area was due to an increase in area under shrimp farms from 94,010 ha in 1987/88 to 108,280 ha in 1988/89.

## 2. FISHERIES IN PROJECT AREA

There are two types of fisheries in the project coastal zone: (1) capture (open water fisheries) and (2) culture (closed water) fisheries. Broadly, culture fisheries are of two types in the project areas: (a) fish culture and (b) shrimp culture. Shrimp culture is again of two types: (i) freshwater shrimp culture and (ii) brakishwater shrimp culture.

### 2.1 Open Water Fisheries

The former greater coastal districts of Chittagong, Noakhali, Barisal, Patuakhali and Khulna, which together amount to some 14000 km2, cover the project area. The area covered by inland open water bodies (except for floodlands) presented in Table 2 reveals that more than 62 per cent of the area under rivers and estuaries of Bangladesh is in the project location. The total area of rivers and estuaries in the project location is 642902 hectares, whose districtwise distribution can be seen in Table 2.

The total fish catch from inland open water sources in the project areas is 166681 mt of which 112437 mt (i.e., 67 per cent) is from rivers and estuaries (Table 3). The project share is around 40 per cent of the total capture fish from the inland open water sources in Bangladesh. In case of rivers and estuaries, the project share is more than 61 per cent of Bangladesh total.

(in hectare)

| District[a] | Type of water body[b] | | |
|---|---|---|---|
| | Rivers & estuaries | Beels | Row total |
| Chittagong | 60010 (5.8[c]) | 89 (0.1) | 60099 (5.2) |
| Noakhali | 95732 (9.3) | 3 (-) | 95735 (8.3) |
| Barisal | 176105 (17.1) | 79 (0.1) | 176184 (15.4) |
| Khulna | 203612 (19.7) | 365 (0.3) | 203977 (17.8) |
| Patuakhali | 107443 (10.4) | - | 107443 (9.4) |
| Project Total | 642902 (62.3) | 536 (0.5) | 643438 (56.1) |
| Bangladesh Total | 1031563 | 114161 | 1145724) |

Table 2: Area Under Inland Open Water Bodies in Project Districts

Source: Estimates of SPARRSO study, 1983.

a. Refers to former greater coastal district.
b. Area data on flood lands by districts are not available.
c. Figures in the parentheses are percentage of Bangladesh total.

(in mt)

| District | Rivers & estuaries | Sunderban | Beels | Floodlands | Row total |
|---|---|---|---|---|---|
| Chittagong | 27009 | - | 198 | 12519 | 39726 |
| Noakhali | 16568 | - | 1 | 9722 | 26291 |
| Barisal | 48300 | - | 27 | 11391 | 59718 |
| Khulna | 4808 | 8066 | 125 | 8973 | 21972 |
| Patuakhali | 15752 | - | - | 3222 | 18974 |
| Project Total | 112437 | 8066 | 351 | 45827 | 166681 |
| Bangladesh Total | 183817 | 8066 | 45610 | 182037 | 419530 |
| Project share as % of Bangladesh | 61.2 | 100.00 | 0.8 | 25.2 | 39.7 |

Table 3 : Distribution of Fish Catch by Inland Open Water Bodies in Project Districts, 1987-88

Source : BBS (1989).

## 2.2 Shrimp Cultivation and Aquaculture

Closed water fisheries in the project coastal districts are shown in Table 4. The project location has 49265 hectare of pond fishery area, which accounts for one-third of the total area of fish ponds in Bangladesh. More than 99% of the shrimp farm area of Bangladesh is in the project districts. District wise shrimp production can be seen in Table 5.

Table 6 reveals that 61% of the total pond area in the project districts are cultured, 29% are cuturable and the remainder 10% are derelict. Fish production from pond aquaculture in the project districts is 53861 mt (i.e., 36% of the total pond fish production in Bangladesh).

(in hectare)

| District | Ponds | Shrimp farms | Row total |
|---|---|---|---|
| Chittagong | 14305 | 24755 | 39060 |
| Noakhali | 11210 | 26 | 11236 |
| Barisal | 11765 | 112 | 11877 |
| Khulna | 5385 | 68363 | 73748 |
| Patuakhali | 6600 | 64 | 6664 |
| Project Total | 49265 | 93320 | 142583 |
| Bangladesh Total | 146890 | 94010* | 240900 |
| Project as % of Bangladesh total | 33.5 | 99.3 | 59.2 |

Table 4 : Area of Closed Water Fisheries in Project Location, 1987-88

a. Khulna has baor area of 331 hectare, which is 6 percent of the total baor area in Bangladesh.
b. Jessore has shrimp farms of 690 hectare.

| Greater Districts | Area Under Shrimp Farms (ha) | Production b/ (mt) | | |
|---|---|---|---|---|
| | | Shrimp | Fish | Total |
| Chittagong c/ | 24,755 | 4,244 | 1,250 | 5,494 |
| Khulna d/ | 68,363 | 13,493 | 6,064 | 19,557 |
| Jessore | 690 | 118 | 35 | 153 |
| Patuakhali | 64 | 11 | 3 | 14 |
| Barisal | 112 | 19 | 6 | 25 |
| Noakhali | 26 | 4 | 1 | 5 |
| Total | 94,010 | 17,889 | 7,359 | 25,248 |

Table 5 : Estimated Shrimp Production from Shrimp Farms, 1987/88a/

Source : World Bank (1991).

a/ Based on information obtained from the Department of Fisheries.
b/ Production was estimated by assuming the following average yields:

| | | |
|---|---|---|
| Khulna | : | Shrimp - 197.38 kg/ha |
| | : | Fish - 88.70 kg/ha |
| Chittagong and | : | Shrimp - 171.44 kg/ha |
| Other Districts | : | Fish - 50.51 kg/ha |

c/ Based on survey of water area in 1986.
d/ Based on survey conducted by Upazila Fisheries Officers (UFOs) in 1987/88.

| District | Cultured[a/] | Culturable[b/] | Derelict[c/] | Total |
|---|---|---|---|---|
| Chittagong | 7224 (50) | 6560 (46) | 521 (4) | 14305 (100) |
| Noakhali | 7548 (67) | 2576 (23) | 1086 (10) | 11210 (100) |
| Barisal | 7199 (61) | 2760 (23) | 1806 (16) | 11765 (100) |
| Khulna | 4161 (77) | 682 (13) | 542 (10) | 5385 (100) |
| Patuakhali | 4039 (62) | 1548 (23) | 1013 (15) | 6600 (100) |
| Project | 30171 (61) | 14126 (29) | 4968 (10) | 49265 (100) |
| Bangladesh | 76383 (52) | 45536 (31) | 24971 (17) | 146890 (100) |

Table 6: Area Distribution of Fish Ponds in the Project Location by Current use Status, 1987-88

Source: World Bank (1991).

a. Where fish fry were released.
b. Where fish fry were not released.
c. Where fish fry were not released and pond condition is not suitable for culturing fish.

In recent years coastal aquaculture has expanded rapidly in Bangladesh because of its profitability and the high expectation of a continuing good export market. According to DoF a total of 108.3 thousand hectare of coastal area have been under shrimp cultivation in the traditional manner yielding 251 kg/ha (Table 7). The total production of shrimp farms is about 3.1 percent of the fish production of the country (Table 1). Even then, Bangladesh exported 17505 metric tons of shrimp and earned foreign exchange worth Tk. 4143 million during 1989-90 (Bhuiyan 1992).

Trapping and growing of shrimps and fish in the tidal channels and low lying intertidal areas has been an age long practice in the coastal areas of old Khulna district. During the past, the practice of brackish water aquaculture was known as 'Bheri fish culture'. Usually large land owners used to encircle a large chunk of land with dwarf dykes. Small canals connecting the enclosed area with tidal rivers or khals were provided with small wooden sluice gates. During spring tides in the months of February to April, the gates used to be opened to allow entry of tidal water carrying juveniles of saltwater shrimp and fin fish.

The trapped young used to be reared for about 4 months and harvested for marketing. Beginning in July, the land within the dykes or ghers used to be washed with rain water repeatedly and a crop of local transplanted Aman rice used to be grown during the period from July to December. During such times in the past, there was no conflict between brackish-water aquaculture and rice farming. Ahmad (1956) reported that more than 100 such rice-cum-shrimp farms were in operation in the then Satkhira sub-division of Khulna district around 1950. This practice was interrupted during the 1960's by the construction of coastal embankments to create polders in the interest of rice production. With the increasing demand and high price of shrimp in the international markets, shrimp farming in the traditional way of trapping and growing started and expanded rapidly in the low lying areas inside and outside the polders in the Khulna and Cox's Bazar regions in the post Liberation period.

| Year | Area (Hectare) | Production (mt) | Productivity (kg/ha) |
|---|---|---|---|
| 1983-84 | 51812 | 8219 | 159 |
| 1984-85 | 64246 | 11282 | 176 |
| 1985-86 | NA | 19951 | NA |
| 1986-87 | 87300 | 22050 | 252 |
| 1987-88 | 94010 | 25248 | 268 |
| 1988-89 | 108279 | 27172 | 251 |
| Trend Rate(%)[a] | 7.51 | 12.66 | 5.15 |

Table 7: Area, production and productivity of Shrimp Farms, 1983-89

NA = Not Available

a. Own estimates using DoF and SAPRRSO data.

### 2.2.1 Current Status of Aquaculture in Project Coastal Areas

Shrimp alone contributes more than 80 percent of the total foreign exchange earnings from the fishery products, which is the third largest source of foreign exchange earnings of the country. Now-a-days the major coastal aquacultural activities include trapping and growing of shrimp and fish in the low lying areas inside and outside the polder in the Khulna and Cox's Bazar regions. Slender peripheral earthen dykes with improvised sluice gates for intake and discharge of tidal waters are generally constructed around the proposed farming areas. Shrimp/fish larval and juveniles coming with the incoming tidal waters are trapped, grown and ultimately harvested after a period of time.

Most of the shrimp ponds constructed during the recent past years have been in areas originally developed for rice in Khulna region (South-western) and Saltpans in Cox's Bazar (Northeast). Because such areas were already cleared within polders, conversion to shrimp culture required relatively low capital investment and returns have been high. While some areas continue to seasonally alternate between rice and shrimp culture or salt and shrimp culture, in other areas shrimp culture alone has proved to be more profitable.

Pond management practices are generally simple, involve few inputs, and have low operational costs. Ponds tend to be larger in size (up to 40 hectare or even more), have poorly constructed dykes and rely on tidal flushing. Most farmers stock 10,000 to 20,000 post larval per hectare which are caught from the wild along with other fish and shrimp, that inadvertently enter into the ponds upon filling with tidal water. More progressive farmers fertilize and prepare their ponds prior to stocking and maintain

well constructed sluice gates with screens. In these well managed farms, yields of up to 700 kg/ha/year are recorded with little or no supplemental feeding. However, the country's average production approximates about 175 kg/ha/year at present.

Trapping and growing of shrimp has opened up an avenue for better utilization of the land. Even after being poldered, the land in the Khulna region, in general remains to be a monocrop area, producing rice during the Kharif season; the land stays fallow during the rest of the year. The land in the Cox's Bazar region is utilized for salt manufactured in the dry season and used to remain fallow during wet months. Now, the majority of farmers in the Khulna region cultivate shrimp in rotation with rice, growing shrimp from January to the end of July and rice from August to December. In the Cox's Bazar region, salt is manufactured from December/January to June and shrimp from July to November. Thus, there has been year round utilisation of land with the introduction of shrimp culture.

A study conducted under the Delta Development Project during the years 1982-83 and 1983-84 had demonstrated in polder 22 that Aman rice yields were not decreased and soil salinities were not significantly changed by the introduction of shrimp farming (Fallon 1984). In a nearby polder i.e. polder 20, shrimp culture alternated with rice cultivation is being carried out under IDA funded shrimp culture Project. In polder 20, data collected by the project officials show that in this area, yield of both shrimp and rice cultivated on the same land have increased.

The rate of production of shrimp through the traditional method of acquafarming is low in comparison to international standards. Furthermore, this system is beset with the problem of unpredictable production. The production is influenced by the availability, as well as the abundance of the quality of natural seed shrimp at the time of impounding. Simultaneous abundance of competitors and predators in nature, which may find entry into the fishery will determine the survival and growth of quality shrimp and their consequent production. The above problems can be solved through production of seed shrimp in hatcheries and the introduction of improved coastal aquaculture technology.

### 2.2.2 Constraints

From less than 20,000 ha in 1974 of brackishwater shrimp cultivation area expanded to over 70,000 ha in 1985 and the area has further been expanded upto 135,000 ha in the coastal regions of the country in 1990 (Nuruzzaman 1991). However, there are different kinds of institutional and physical constraints (e.g. slow rate of technology transfer, inadequate credit facilities, lack of experience, want of low-cost supplementary feed, marketing constraints, etc.) to the development of coastal aquaculture in Bangladesh.

Specific Constraints to the development of coastal aquaculture in Bangladesh have been identified by ASR/UNDP (1989). Out of those constraints, the following below relates to cyclones and tidal bores:

a. High tidal amplitude leads to soil erosion and washes away the essential natural food. Soil erosion can be prevented by making strong boundary dykes but these will require high capital investment.

b. Frequent cyclones accompanied by tidal bore in recent years make any capital investment very risky.

c. Due to the large crab population, the bottom of the gher/pond often becomes full of holes which can cause serious damage to the shrimp farm embankments and also become an escape route for the stock. It is controllable at extra cost.

d. Uncertain availability of quality seed for stocking. At present wild seeds are collected and handled in a crude way which leads to high mortality prior to stocking. This problem can be solved through the introduction of efficient catching and handling techniques of the post larval stock followed by the development of hatchery technology for the mass production of seeds.

e. Change in the ecological condition of the coastal areas through conversion of mangroves to ponds. Mangroves are believed to be important breeding and nursery grounds for many aquatic species which are later caught in the nearshore areas by capture fisheries.

### 2.2.3 Mangrove and Shrimp Cultures

Bangladesh has a continuous coastal line along the Bay of Bengal, which is about 710 km in length. It supports about 587,380 ha of natural mangrove forests and a further 24,120 ha of planted mangrove forests (Mahmood, 1986).

The mangroves are believed to be important breeding and nursery grounds for many aquatic species that are later caught in the nearshore areas. Moreover, inter alia, they are supposed to play a vital role in -

a. Creating a protection belt along the sea coast;

b. Protecting the coastal fisheries against cyclones and storm surges.

Inspite of the above uses, there are institutional weaknesses that encourage the conversion of mangroves to shrimp culture under private ownership or use rights. In addition, scientific studies have been unable to establish the

exact quantitative relationship between mangroves and nearshore fisheries (Hamilton and Snedaker, 1984). However, positive correlations have been found between the extent of mangroves and the size of shrimp fishery in adjacent waters in several countries (Macnae, 1974; and Martosubroto and Naaim, 1977). The inference that fish catches will decline in proportion to mangrove destruction is a reasonable one and supported by observations from the Malacca strait where extensive mangrove destruction for industrial purposes has been paralleled by a substantial drop in catch per unit of fishing effort (Khoo, 1976). The potential fisheries losses that may occur by clear cutting the mangroves are usually understated, if stated at all, in cost/benefit studies of coastal aquaculture. Other traditional users of mangroves areas such as shellfish gatherers, charcoal makers and nipa palm or golpata growers are frequently ignored in these calculations, though the value of these activities may be substantial (Velasco, 1980 and Ong. 1982).

In Bangladesh, shrimp farming is done in the coastal areas alternated and/or coupled with agriculture (rice production) or salt production. Shrimp beds are used for salt production in the Chittagong region only. In the Cox's Bazar area, salt is manufactured from December/January to June and shrimp from July November. The majority of the farmers in the Khulna region cultivate shrimp in rotation with rice growing shrimp from January to mid July and paddy from August to December.

In the Chittagong region, shrimp farmers destroy mangroves forest for the conversion of the coastal areas into shrimp ponds whereas the shrimp farmers do not destroy the mangrove forest in the Khulna region.

### 2.2.4 Conflicts

The conflicts arise between the use of land for shrimp and for rice cultivation in some areas. In areas where shrimp and rice are grown together or side by side, conflicts may arise when shrimp farming imposes new or unwanted conditions upon adjacent rice fields. The direct effects of shrimp farming on adjacent rice fields depend on local conditions and water control systems. While these effects may harm HYV rice in the winter, the cultivation of Aman rice on land that had been flooded with saline water during winter is possible and is currently in practice in the Khulna region.

The degree of conflict decreases towards the south from Satkhira district because the upazilas of Shyamnagar, Assasuni and Kaliganj have land conditions which are more suitable for shrimp production than for rice production. These areas do not seem to experience conflicts. Shrimp and rice can be grown as a two crop system in the Khulna region while shrimp yields are slightly lowered when shrimp is followed by rice, the returns are good enough and the employment per unit of land is enhanced.

## 2.3 Strategies and Modes of Development of Coastal Aquaculture

The ever increasing demand and high price of shrimp in the international markets provide an excellent opportunity to enhance production of shrimp in Bangladesh. The coastal land areas having the most suitable physico-chemical environment for brackish water shrimp aquaculture should be delineated. On those areas saline water entry on the land should be allowed for shrimp culture.

Table 8 shows the principal modes of brackish water aquaculture development. The average annual costs and net return under different modes of fisheries development have been shown in Table 9. Table 10 shows the projected growth of the area of coastal shrimp aquaculture in Bangladesh.

Alternative A is based on growth at the rate of five percent per year (from the 1983 level) for Cox's Bazar only with hatcheries located there. Alternative B is based on a 10 percent increase per year in Satkhira and a five percent increase per year for all other locations (except Begerhat where low water salinity inhibits further growth) are expected with the establishment of hatcheries in all the areas.

| Sl. No. | Mode | Major Physical Components |
|---|---|---|
| 1. | Shrimp/fish only (present practice) | Minor embankment, earthwork, wooden inlets, post larvae and traps. |
| 2. | Shrimp and rice (present practice) | Minor embankment, earthwork, wooden inlets, post larvae, traps and additional inputs for rice cultivation |
| 3. | Shrimp and salt (present practice) | Minor embankment, earthwork, wooden inlets, post-larvae, traps and additional embankment for salt |
| 4. | Shrimp only (semi-intensive) | Major embankment, earthwork, fertilizer, lime, screened inlets and outlets, concrete regulators, and post-larvae |
| 5. | Shrimp only (Intensive) | Major embankment, earthwork, screened inlets and outlets, concrete regulators, post-larvae, fertilizer, lime and feed |
| 6. | Shrimp only and rice (improved) | Shrimp: Major embankment, earth work, screened concrete inlets and outlets, larvae and fertilizer. Rice: Required inputs for rice cultivation |
| 7. | Shrimp only and salt (improved) | Shrimp: Major embankment, earthwork, screened concrete and outlets, post larvae and fertilizer. Salt: Additional earthwork |

Table 8: Principal modes of brackish water aquaculture development in Bangladesh

Source: MPO (1986)

Tk/ha

| Mode | Gross Return | Capital Cost | O & M Cost | Total Cost | Net Return |
|---|---|---|---|---|---|
| Traditional Modes | | | | | |
| Shrimp only | 34,760 | 1,298 | 17,632 | 18,930 | 15,830 |
| Shrimp and Rice | 47,200 | 928 | 17,321 | 18,249 | 28,951 |
| Shrimp and Salt | 28,040 | 842 | 17,328 | 18,170 | 9,870 |
| Improved Modes | | | | | |
| Shrimp (semi-intensive) | 146,000 | 4,728 | 45,528 | 50,256 | 95,744 |
| Shrimp (intensive) | 292,000 | 7,637 | 83,075 | 90,712 | 201,288 |
| Shrimp and Rice | 83,180 | 4,728 | 29,552 | 34,280 | 48,900 |
| Shrimp and Salt | 89,440 | 4,728 | 29,552 | 34,280 | 48,900 |

Table 9: Average annual costs and net return to farmer for a 50 ha brackish water aquaculture farm at 1983 market price

Source: MPO, 1986.

(in ha)

| Year | Name of district | | | | Total |
|---|---|---|---|---|---|
| | Satkhira | Khulna | Bagerhat | Cox's Bazar | |
| 1983 | 8,001 | 12,821 | 11,012 | 18,671 | 50,505 |
| 2005 (Alternative A) | 22,000 | 17,308 | 25,000 | 45,740 | 110,048 |
| 2005 (Alternative B) | 34,000 | 30,290 | 25,000 | 45,740 | 135,030 |

Table 10: Projected growth of the coastal shrimp aquaculture area Medium forecast of farm area

Source: MPO (1986).

## 2.4 Reference to IDA Financed Shrimp Culture Project

The IDA financed Shrimp Culture Project aims to enhance the production of shrimp in the coastal areas of Bangladesh through introduction of improved shrimp culture technology consisting mainly of improved water management and other related management practices. In respect of improved water management, Cyclone Protection Project II is supportive to the Shrimp Culture Project.

Under the Shrimp Culture Project, an area of 7024 ha in the coastal belt in the districts of Khulna and Cox's Bazar will be developed. Out of this total area, 5594 ha would be in Cox's Bazar (Polders 70, 66/4 and 66/3; Rampur sub-polders 1,4 and 5) and 1430 ha in Khulna.

The main infrastructural activities for Polder 70 as planned under the Shrimp Culture Project are:

| | | |
|---|---|---|
| Peripheral embankment | : | 22.69 KM |
| Peripheral channel | : | 22.50 KM |
| Dwarf embankment | : | 13.40 KM |
| Internal channel | : | 20.34 KM |
| Regulators | : | 7 Nos. |
| Sluice repair | : | 3 Nos. |

The progress of infrastructural activities in polder 70 compared to other polders has been very poor, with physical and financial completion to date are respectively only 11% and 4%. The main reason of this slow progress as opined by the project officers is that BWDB is in the process of taking decision that most of the infrastructural activities in the polder 70 will be done under the Cyclone Protection Project II. The project officers have also reported that since already there are dykes and sluices in polder 70 and the infrastructural activities will be partial ones, cost recovery from the private land owners cannot be done. The private land owners will submit shrimp credit projects and they will take loan from Bangladesh Krishi Bank, Sonali Bank and Agrani Bank.

## 2.5 Coastal Fisheries Damages by 1991 Cyclone

Fisheries damages in polders 70 and 68 by 1991 cyclone are given in Tables 11 - 15.

| Nature of Damages | Estimated Damages (Lakh Tk.) |
|---|---|
| Damages on peripheral dykes, with large breaches and damages on sluices | 599 |

Table 11 : Public Sector Fisheries Damages by 1991 Cyclone in Polder 70.

Source : Own assessment using the available information from BWDB and DoF.

| Nature of Damages | Estimated Damages (Lakh Tk.) | % Total Damage |
|---|---|---|
| Farmer's dykes and internal gates | 1254 | 24.5 |
| Main embankment (BWDB) and regulators | 1878 | 36.7 |
| Shrimp (1020 MT at the rate of 1.7 lakh Tk. per MT) | 1734 | 33.9 |
| Fish (510 MT at the rate of 0.3 lakh Tk. per MT) | 153 | 3.0 |
| Salt | 95 | 1.9 |
| Total Damages | 5,114 | 100.0 |

Table 12 : Private Sector Fisheries Damages by 1991 Cyclone in Polder 70.

Source : Own assessment utilizing the available information from DoF.

| Nature of Damages | Estimated Damages (Lakh Tk.) |
|---|---|
| Damages on peripheral dykes, with large breaches and damages on sluices | 203 |

Table 13 : Public Sector Fisheries Damages by 1991 Cyclone in Polder 68.

Source : Own assessment.

| Nature of Damages | Estimated Damages (Lakh Tk.) | % Total Damage |
|---|---|---|
| Farmer's dykes and internal gates | 424.0 | 24.4 |
| Main embankment (BWDB) and regulators | 635.0 | 36.5 |
| Shrimp (345 MT at the rate of 1.7 lakh Tk. per MT) | 586.5 | 33.8 |
| Fish (172 MT at the rate of 0.3 lakh Tk. per MT) | 51.6 | 3.0 |
| Salt | 34.0 | 2.0 |
| Engine boat | 6.0 | 0.3 |
| Total Damages | 1,737.1 | 100.0 |

Table 14 : Private Sector Fisheries Damages by 1991 Cyclone in Polder 68.

Source : Own assessment.

| Polder | Location | Estimated Damages (lakh Tk.) | | |
|---|---|---|---|---|
| | | Public | Private | Total |
| 68 | Teknaf | 203.0 | 1737.1 | 1940.1 |
| 70 | Matharbari | 599.0 | 5114.0 | 5713.0 |
| Overall | | 802.0 | 6851.1 | 7653.1 |

Table 15 : Overall Public and Private Sector Fisheries Damages by 1991 Cyclone in the Polders 68 and 70.

Source : Own assessment depending on available data from BWDB and DoF.

# 3. IMPACT OF PROJECT ON FISHERIES

## 3.1 Positive Impact

Infrastructural improvement and proper operation of sluices solving the problems of congestion as well as water shortage are expected to be the positive benefit of the Cyclone Protection Project II. In general, the potential positive impact of the project on fisheries subsector will mainly be in the form of protection, extension and improvement of cultural fisheries:

Cultural fisheries resources (shrimp farming, pond aquaculture) inside the embankment will be protected from floods and cyclonic surges. In the absence of embankments for cyclone protection, the ponds and shrimp farms in the project areas are subject to overflow of their bunds during cyclonic surges and floods. Ponds and shrimp farms are likely to be less prone to such overflow if sea defence and associated water control structures are rehabilitated, improved or extended. In the past the owners were hesitant and even reluctant to stock their ponds and apply inputs because of the perceived risks, this risky situation has improved today after the construction of coastal embankments. The proposed project will further improve the situation. It can be recalled from the Table 6 that aquaculture status of ponds in the project coastal districts appear to be better relative to Bangladesh average. More and more culturable and derelict ponds are expected to be brought under fish culture with the implementation of project. In general, the level of technology use in coastal aquaculture will be improved in the risk-free situation.

In the project, priority will be assigned to seafaring polders vulnerable to monsoon waves and cyclonic surges. As such, the fisheries activities in and outside the polder areas will extend and accelerate. In this connection, it is useful to list out the polders of fisheries importance under Cyclone Protection Project II:

| Polders | Remarks |
|---|---|
| 5,7/1, 7/2, 10-12, 14/1, 14/2, 15, 31, 32, 35/1, 40/1 | Already there is psciculture inside the polders |
| 40/2, 45, 48, 57/56 | There is scope for psciculture inside and outside the polders |
| 59/2, 61/1, 62 | There is space outside the polders suitable for fish culture |
| 63/1a, 64/1a, 64/2b, 66/1, 66/3, 68, 69, 70, 71 | Most of the space outside and inside the polders are utilized for psciculture and shrimp culture in particular |

High tidal amplitude causes soil erosion and washes away the essential natural food for shrimp. The project will help solution of this problem.

The efforts towards the development of hatchery technology for the mass production of shrimp seeds will become risk-free with the implementation of the Cyclone Protection Project II.

With the expansion and improvement of cultured fisheries activities in the project coastal zone, income and employment opportunities would be diversified and increased.

### 3.2 Negative Impact

There are evidences that construction of coastal embankments have eliminated or reduced the periodically available nursery and grazing grounds (during the high tides) for the young and juveniles for a number of marine and estuarine shrimp and fin fish (MPO 1987).

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## 4. ECONOMIC EFFECT OF PROJECT IMPACT ON FISHERIES

More accurate social and economic data are required for actual estimation of economic effect of the project impact on the fisheries subsector. However, from the available evidences and potential positive and negative impacts described in this report, it appears that the net economic effect of project impact on the fisheries subsector would be positive. In fact, economic value of the positive impact of the project in the form of protection, expansion and improvement of cultural fisheries is expected to be substantially greater than that of the negative impact on open water fisheries.

quantified?

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