Government of the People's Republic of Bangladesh

Ministry of Irrigation, Water Development and Flood Control
Flood Plan Coordination Organization

BANGLADESH ACTION PLAN FOR FLOOD CONTROL

COMPARTMENTALIZATION PILOT PROJECT (FAP 20)

TANGAIL CPP INTERIM REPORT

ANNEX 3 : FISHERIES AND AQUACULTURE

(DRAFT)

September 1992

Euroconsult/Lahmeyer International/Bangladesh Engineering & Technological Services/House of Consultants

under assignment to

DIRECTORAAT GENERAAL INTERNATIONALE SAMENWERKING
Government of the Netherlands

and

KREDITANSTALT FÜR WIEDERAUFBAU
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BFRSS	Bangladesh Fisheries Resources System
CPP	Compartmentalization Pilot Project or FAP 20
CPUE	Catch Per Unit Effort
DOF	Directorate of Fisheries
FAP	Flood Action Plan
FCD/I	Flood Control and Drainage
GOB	Government of Bangladesh
HA	Hectares
HH	Households
HYV	High Yielding variety
MDSC	Multi-Disciplinary Sub-Compartment Survey
MPO	Master Plan Organisation
MSY	Maximum Sustainable Yield
SEM	Standard Error of the Mean
SPP	Species
T	Ton
KG	Kilogram

iv SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

0.1 The fish species in Bangladesh can be divided in two major groups when their reproductive behaviour is taken into account:

River fish, such as the major carps, are spawning upstream in the major rivers at the beginning of the rainy season. The eggs, larvae, fingerlings and some adults of these species flow with the water current downstream, finally entering the floodplain, where they find all the nutrient for survival and growth. These species migrate back to the river as soon as the water recedes from the floodplain.

Beel fish, such as snakeheads, catfish, etc, can survive the harsh condition of the floodplain. They reproduce in the pre-monsoon as the water level in the beel rises. Nursing takes place in the inundated floodplain. With the receding waters this group migrates back or get trapped in the low lying beels.

Throughout the whole fisheries study of FAP 20, this difference has been a key point of attention due to the fact that water management regulations affect both groups in a different way.

0.2 Within Bangladesh the Department of Fisheries is monitoring fisheries and aquaculture, through the Fisheries Resources Survey System. This monitoring system indicated a decline of 44.000 ton/year in fisheries production obtained from rivers, floodplain and beels during the period 1983-1989. Within the same period the inland aquaculture output of Bangladesh increased with 48.000 t/year, covering up the losses of inland fisheries. The present production of 1000 kg/ha/year obtained from managed ponds could be increased to a maximum of 2000 kg/ha/year through improvement of the methods used, giving a maximum aquaculture output of 100.000 t/year. It can be concluded that there is not much room left for a continuing making up of captured fisheries losses by aquaculture.

0.3 The main reasons for the decline of the inland capture fisheries output are;

- Blockage of migration routes of carp spp
- Reduction of fish breeding and nursing habitats
- The massive capture of fry for aquaculture purpose
- The increased fishing intensity
- The increased use of agro-chemicals
- The disease known as Epizootic Ulcerative Syndrome which especially attacks Beel fish, which spread over South East Asia in the last decade.

0.4 The total fish production of Tangail district increased from 5.500 t/yr in 1983 to 7.000 t/yr in 1989, mainly due to an increased floodplain fisheries output. It is assumed, however that this increase is caused by errors in data collection due as these figures are in contradiction with the general trend of Bangladesh. Both riverine and beel fisheries declined substantially within the last decade.

0.5 Within the CPP-project area the general trend of reduced fisheries output was reported by

the professional fishermen during the MDSC-Survey. However reliable data on the past or present situation could not be compiled from the Fisheries statistics. The total fisheries output of the CPP area was estimated at 420 t/year, using the data from the Fisheries Household Survey. The distribution over the different habitats is presented below.

HABITAT	CATCH IN TON/YEAR
RIVER	44
BEEL	127
FLOODPLAIN	183
PITS & DERELICT PONDS	26
AQUACULTURE	40
TOTAL	420

0.6 Fishing activities in the project area can be divided in:

Professional fishermen, their main occupation is fishing throughout the year and their number in the CPP area is estimated at 460.

Occasional fishermen, these fishermen have next to fishing an alternative occupation and approximately 930 are active in the CPP area.

Subsistence fishermen, The majority of the fish, in Bangladesh and in the CPP area, is caught by this group. The catch is mainly meant for home consumption.In The Fisheries Household Survey their number is estimated to amount 17.290.

0.7 A survey executed by FAP 20 indicated the existence of approximately 350 culturable ponds, within the CPP area. The main species cultured are: Major or Indian carps, Silver carp, Common carp, Tilapia and Grass carp. Fry is mainly obtained from natural sources, expect the chinese carps. The actual aquaculture production is estimated at 40 t/year, with an average pond size of 0.1 ha and a production level of 1200 kg/ha/year.

0.8 Tangail district and the CPP area are the lowest inland fish producers of Bangladesh providing approximately 1% of the total inland fisheries production. As a consequence the per capita availability of fish is 1.83 kg only, which indicates that a substantial amount is obtained from outside the project area. The major part (85%) of the fish consumed in the rural area of the CPP area consist of the so called "small" or "miscellaneous" species, most of them originating from the Beel areas.
A fivefold increase, or 1970 t/year of fisheries output is needed in the CPP area, in order to secure the future demand (year 2020) at the present average consumption rate of 7 kg/capita/year. With the present situation, such an increase can not be obtained and the CPP area will become even more dependent on outside resources.

0.9 The establishment of new or "appropriated" water management systems, always affects the fish population and consequently the fisheries output. From a Fisheries point of view it can be stated that the major part of the water management systems established until now in Bangladesh, serve to increase outputs from agriculture and to provides flood protection. Two major factors negatively effects the natural fish stocks:

Drainage of rainwater congestion around the Beels in the pre monsoon in order to secure the crops of the low land farmers hampers the reproduction and nursing of "Beel" fish.

Reduction of the inundated floodplain area by drainage in the monsoon and post monsoon and subcompartment water management systems reduces the total available nursing and grow out area for both "River" and "Beel" fish.

0.10 In order to asses the impact on fisheries of the different water management systems, studied by the FAP 20 team, a three step analyses was developed. The hydrographs from the CPP-mathematical model were linked with a fisheries production model and calibrated with the fisheries and hydrological data of 1991. The predicted total fish production under each scenario was subsequently subdivided species wide in order to create a differentiation in fish prices.

0.11 All 12 scenario's have a negative impact on the fisheries production of the CPP area. The minimum loss will be 47 t/year or 63.000 US$/year (scenario 9, peripheral control with "fish friendly" regulators) and maximum loss, 138 t/year or 176.000 US$/year, will be created by the introduction of scenario 4, small gated inlets. In general it is concluded that the highest losses are found in the more sophisticated water management schemes.

0.12 Complete peripheral control and complete peripheral control combined with subcompartment water management are principal scenario's. These scenario's can be implemented by taking into consideration the technical aspects of water management only or by taking into consideration both water transport and fish migration. The difference between implementation with or without "fish friendly" structures is limited, caused by the fact that the structures only are facilitating the migration of the major carps hatchlings. The scenario's are compared with the existing situation of 1991, which consists of a declined carp production due to factors beyond the influence of the CPP project. Therefore evaluating "fish friendly" or "standard" regulators on the bases of economic parameters only, must be questioned.

0.13 Mitigation measures,such as the integrated farming of rice/fish and culture based fisheries are studied. Even if the integrated farming of rice/fish is profitable, it will be hampered by the fact that this culture pattern is traditionally unknown with the farmers and that at present the use of HYV is the nucleus of rice farming in Bangladesh. From a technical point of view, culture based fisheries is a tool to restore some of the lost natural carp production. A preliminary technical and financial analysis of this mitigation measure indicated that as a prerequisite each fishermen should have access to 4 ha of water. Moreover, low priced small fry or fingerlings should be readily available.

0.14 Fisheries projects in Bangladesh are up to now mainly focusing on the high valued carp species. The growth of aquaculture within the last decade was possible because carps are

"high" valued, making it economically feasible to culture them, and losses were more or less compensated. However, the major part of the rural population depends on the natural resources for its daily animal protein intake, which consists of "miscellaneous" or "small" fish, and can be caught freely, because the rural population traditionally has a free access to the waters, with their common fishing gears. Therefore when water management systems and fisheries are evaluated, factors other then economic or production figures on a kilogramme bases must also be taken into consideration. Even the at first sight less harmful option of "drainage only", affects directly the production of this free accessible source of protein. Mitigation measures should also be evaluated within this setting. The introduction of culture based fisheries can compensate some of the fisheries losses, but at the same time it will worsen the situation of the rural poor, because a shift from "free access" to "limited access" will take place.

0.15 The restoration of carp fisheries is beyond the limits of the CPP-project, but limitation of the losses of "Beel" due to the introduction of water management systems can be influenced. A Beel concept is proposed, in which the low land farmers are not recuperating all the potential available agriculture land, thus keeping partially intact the environmental conditions, needed for reproduction and nursing of the "beel" fish.

0.16 The evaluation of FCD/I projects on fisheries is hampered by the fact that most often no Base-line information of the pre-project situation is available. Therefore a Special Fisheries Study started in May 1992 in cooperation with FAP 17 and FAP 16. This study covers the following aspect of fisheries:

Frame Survey
Catch assessment
Hatchling migration of major carps
Adult fish migration
Reproductive behaviour of Beel fish

The first results will be forthcoming by the middle of 1993.

1. INTRODUCTION

1.1 Bangladesh, situated in the delta of three large rivers and their tributaries, the Brahmaputra (Jamuna), the Ganges (Padma) and the Meghna, drains a huge catchment area outside the country, as well as the total surface of the country itself (142 000 km^2).
The watersheds of these three river systems receive an average annual rainfall of 210 cm, 140 cm and 400 cm respectively. This rainfall combined with the snow-melt over the Himalayas generates a yearly runoff of approximately 1.5 million cubic meters. However the topography of the country does not allow an easy drainage of these quantities and consequently 30-40% of its area is flooded with nutrient rich water for almost six month a year.

1.2 Within the national context the annual fish production of approximately 840.000 mt plays an important role in the economy of Bangladesh. The sector accounts for 3% of GDP, 11 % of export earnings and 70% of the animal protein intake of its population. Inland fisheries and aquaculture are the major contributors of fish covering respectively 50% and 22% of the total production (DOF, 1990[1]).

1.3 The scope of the fisheries component in the Compartmentalization Pilot Project (CPP, or FAP 20) is to increase the availability of fish by securing fisheries production and by improving aquaculture. It is realised that this aim can only be attained with a thorough understanding of: the fish, the fishermen, their behaviour and habitats.

1.4 In spite of the numerous publication/reports written and efforts directed into fisheries of Bangladesh, the "knowledge" needed for real understanding and the quantitative data needed for policy making is scarce or not yet published. Several programs such as: Department of Fisheries Resources Survey Systems (BFRSS), Third Fisheries Project, FAP 17 9 (Fisheries), are on it way to narrow this gap.

1.5 Within FAP 20 it is realised that profound knowledge of fisheries in the project area cannot be obtained through a survey executed in one season. Therefore a Special Fisheries Study has been started in May, 1991, in order to cover numerous aspects of fisheries within the CPP project area throughout a whole year. The at present status of information is given but will be cross-checked with result of the Special Fisheries Study and results of FAP 16 (Environment) and FAP 17 (Fisheries).

1.6 Traditionally, the term "Fisheries" is considered to encompass both aquaculture and captive fisheries. However, the technical natures of these two activities are completely different. Aquaculture has a "culture" pattern while captive fisheries has a "hunting" one. This difference must be taken into account when development options are formulated. For captive fisheries a management strategy should be developed in order to profit maximally from the existing fish stocks without destroying them (sustainable yielding). Aquaculture is more like farming and aims principally at optimum economic output. Within this context the word **fisheries** will refer to captive fisheries only in this report.

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[1]BBS. 1989. Statistical Yearbook of Bangladesh, 1989 and previous issues.

2 FISHERIES RESOURCES IN BANGLADESH

2.1 Fish resources of Bangladesh can be divided into three categories each with its own subdivision:

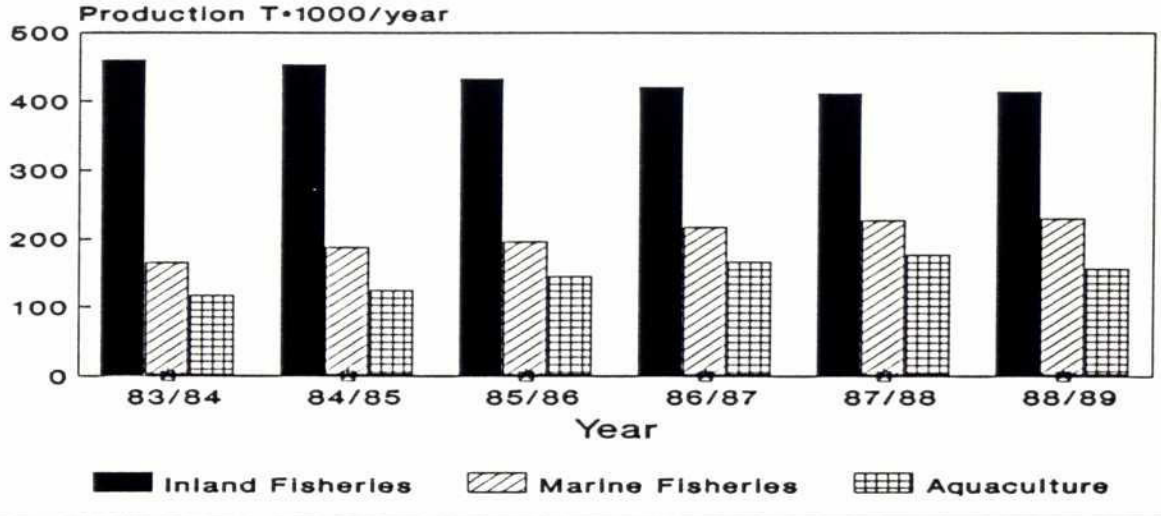
(a) Marine Fisheries
  1 Industrial trawling
  2 Artisinal fisheries

(b) Inland Fisheries
  1 river fisheries
  2 floodplain fisheries
  3 beel fisheries

(c) Aquaculture
  1 fresh water pond culture
  2 Culture based fisheries
  3 Shrimp and Prawn culture

The production performance[2] of the three categories is given in Figure 1
The data show that the overall production of marine fisheries and aquaculture increased and that the overall production of inland fisheries decreased within the last decade.

Figure 1: Fish resources of Bangladesh and their production



[2]Department of Fisheries. Fish Catch Statistics of Bangladesh, 1983-89, Fisheries Resource Survey System, Dhaka.

3. BIOLOGICAL CHARACTERISTICS OF FISH COMMUNITIES IN BANGLADESH

A Hydrology and its impact on nutrients and water quality

3.1 The seasonal variations of flow in the rivers and the congestion of water in the depressions of the floodplain are the main factors influencing the behaviour of fish communities in Bangladesh.

3.2 The hydrology of the floodplain and rivers of Bangladesh can be divided in four periods each with its own characteristics:

(a) Pre-monsoon: The water level in the rivers and depression areas (beels) of the floodplain raises due to the early rains. The rising water invades the nearby plains and organic and inorganic matter lying on the plains enters solution, providing the nutrients needed for biological production.

(b) The monsoon: The continuous rainfall and the influx of water in the upper catchment areas saturates the main channels, the water continues to rise and eventually spills over through a system of channels inundating the floodplain and the low lying depression areas completely. Debris of animal and vegetal origin starts rotting and the availability of nutrients in the water increases rapidly.

(c) Receding waters: At the onset of the dry season the water in the floodplain start to flow back in the main channels. Gradually the floodplain dries up and the low lying "beels" and "pagars" are cut off again from the main river systems.

(d) The dry season: Within the dry season the evaporation and drainage of water exceeds the influx of water. As a result the water level in the rivers and permanent water bodies of the floodplain decreases.

B The behaviour of fish communities

3.3 Two main factors influence the behaviour of fish communities in Bangladesh.

(a) The nutrient influx during the pre-monsoon and monsoon provides favourable breeding, feeding and nursery areas for the most species of fish.

(b) The increasing harshness of the environment of the permanent water bodies of the floodplain during the dry season.

3.4 On the basis of their behaviour, mainly related to migration and reproduction, the fish species of Bangladesh can be divided in three groups:

(a) The so-called **"white fish"**[3] migrate upstream and laterally to the inundated oxbow lakes and embankments adjacent to the river channel in the late dry season or early rainy season in order to spawn in the quiet sheltered and nutrient rich waters. The eggs and new born larvae of these species are transported passively by the flood into the floodplain area, where they feed on the developed plankton. At the end of the rainy season, the adults and young of the year escape to the main channel in order to avoid the harsh conditions of the floodplain during the dry season. "White" fish belong mainly to: Cyprinidae and Pangasidae, (Mrigal,Rui,Katla, Pangash, etc). Further in this report this group will be referred as "river fish".

(b) The so-called **"black fish"** are mainly omnivorous/carnivorous bottom dwellers, They reproduce at the onset of the pre-monsoon as the water level in the "beels" starts rising due to the congestion of rain water. They general have complex breeding pattern with multiple spawning, a great degree of parental care and migrate only laterally. At the end of the rainy season the young of the year and adults migrate back to, or get trapped in the low lying "beels" where they can survive the harsh conditions of these permanent water bodies during the dry season. They are adapted to resist low dissolved oxygen concentration and high water temperatures. The main adaptation is their auxiliary respiratory organ used for the uptake of atmospheric oxygen. The main species of the "black" fish are belonging to the Clariidea (Magur), Ophiocephalidea (Taki, Shol) and Anabantidae (Koi,Khalisha). Further in this report this group will be referred to as "beel fish".

(c) The so-called "riverine floodplain spawners " are those species of which adults migrate active or passive during the high flood to the floodplain in order to spawn in the fast inundated areas. First results of the Special Fisheries Study indicates that Mystis spp (tengra) could belong to this group.

[3] "White" and "Black" fish is a terminology used in the Mekong Delta river system

4. FISH CONSUMPTION

A Bangladesh

4.1 The data on availability of fish or consumption of fish for Bangladesh are not uniform. The annual per capita availability of fish decreases from 8.1 kg in 1975 to 7.6 kg in 1989 when only the total fish production and the population is taken into account. According to the results of the Household Expenditure Surveys the average annual per capita intake of protein increased from 9.8 kg in 1974 to 13 kg in 1986[4]. This discrepancy could be explained by an underestimation of the fish catches, especially the subsistence catches, by DOF. It is expected that the importance of the subsistence catches within the rural areas (see 4.12) would be reflected by a difference in per capita consumption between the rural and urban poorest groups. However as Table 1 indicates this is not the case.

TABLE 1: The relation between household income and per capita fish consumption in 1985/86

Monthly Household Income Group (Tk)	Annual per Capita fish consumption Rural (kg)	Urban (kg)
< 500	4.36	4.82
1.000 - 1.250	8.51	10.31
2.000 - 2.499	12.88	14.00
4.000 - 4.999	15.46	18.02
> 8000	21.70	22.06

Source: Worldbank, Fisheries Sector Review, 1991.

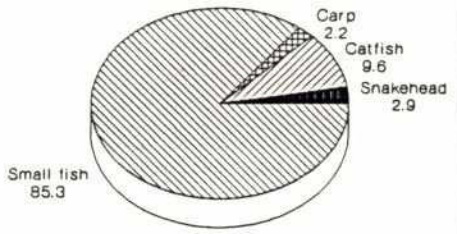
B CPP project area

4.2 The results of a preliminary household consumption survey of fish, rendered in September/October 1991, by FAP 16 in several districts of Bangladesh indicated the importance of the so called "small" fish (see Figure 2). For the CPP project area, surveyed at 13.11.81, the figures were: 12.5 % snakeheads & catfish, 2.2 % carps and 85.3 % small fish. The same study indicated that 62 % of the fish consumed was caught and 35% was bought. It should be remarked that this study was preliminary,and done in the rural areas, with relatively few samples only . The final household consumption survey of FAP 16 within the CPP area started in December 1992. The final results of this survey will be used in the Special Fisheries Study. Secondly it should be remarked that for the whole fish consumption within the CPP area the Town of Tangail is of utmost importance and is not yet covered.

[4]Bangladesh Bureau of Statistics, 1980, 1986, 1988.

4.3 The total fish production of the CPP project area has been estimated at 420 t/year (see 8.5). With a population of 230.000 within the CPP project area, this production gives an annual per capita availability of **1.83 kg** only. This figure should be regarded within its perspectives (see 5.4). Tangail district is together with Kusthia district the lowest inland fish producer of the whole of Bangladesh, each producing approximately 1% of the total inland fish production. Reasons could be: the highly developed agriculture, the physical and biological conditions, the density of FCD/I projects, the population density and urbanization level or a underestimation of the fish catches.

Figure 2: Consumption of fish by groups
In % of meals



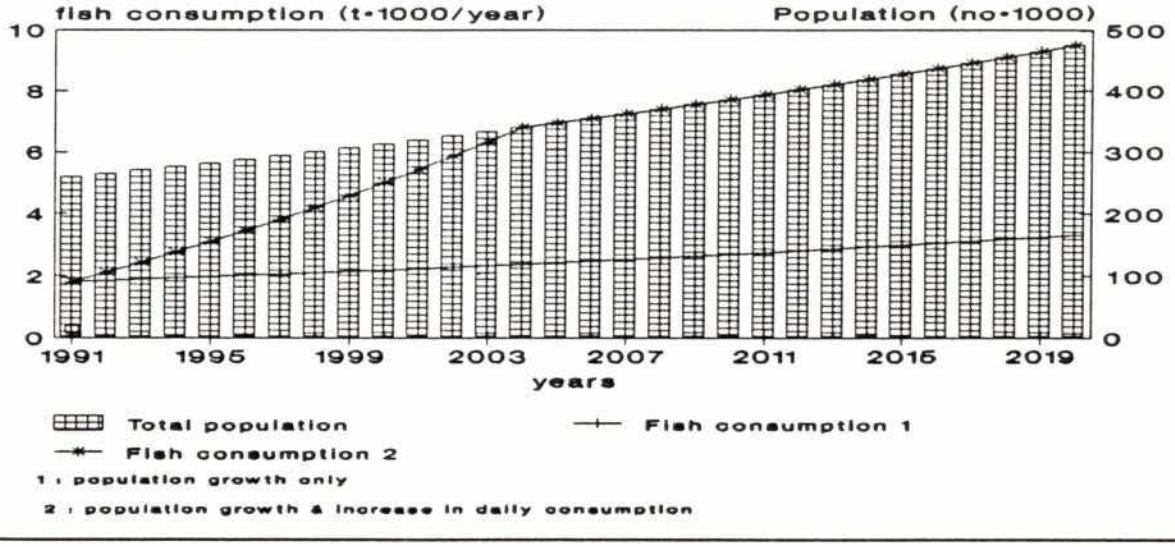
Source FAP 16

4.4 The future demand for fish in the CPP project area will be determined by the population growth and eventually by increased daily consumption patterns. Figure 3, presents the annual quantity of fish needed under two assumptions:

(a) Consumption patterns remains stable at 7 kg/capita/year and the population increase is 2.15 %/year.

(b) The consumption pattern increase to 20 kg/capita/year (FAO recommendations) and the population increases with 2.15 %/ year.

Figure 3: Predicted fish consumption in the CPP area

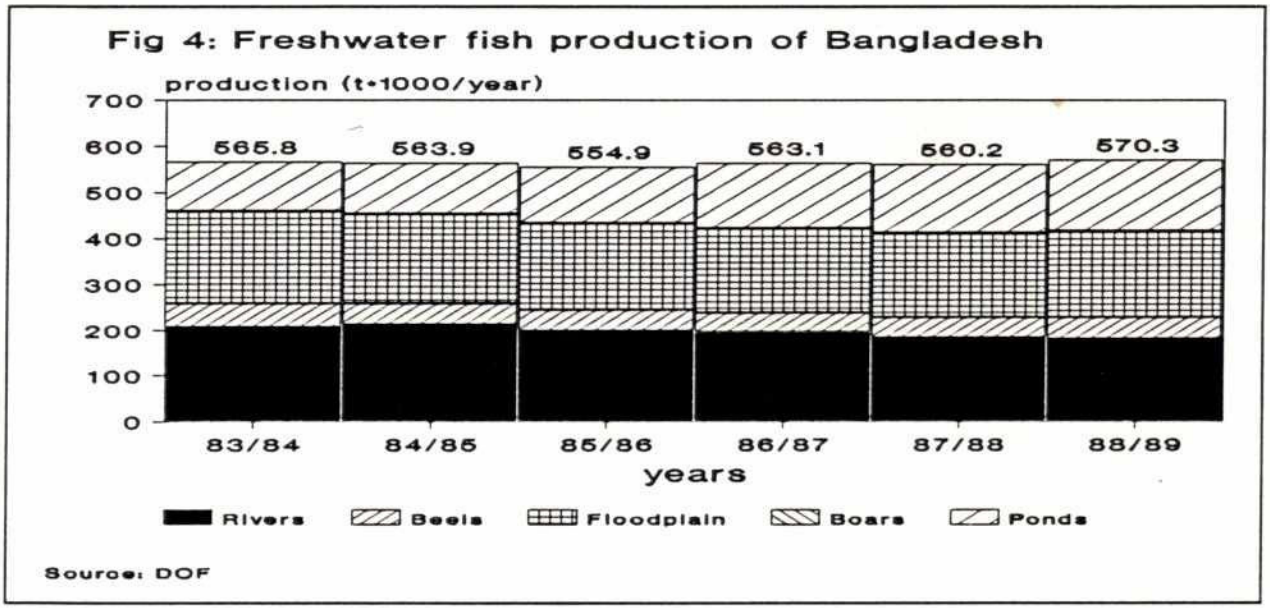


It indicates an increase of 1970 T and 5171 T, for respectively option a and b, or a fivefold and twelvefold increase,if the actual annual production estimated at 420 ton/year. It indicates the significance of reliable consumption data.

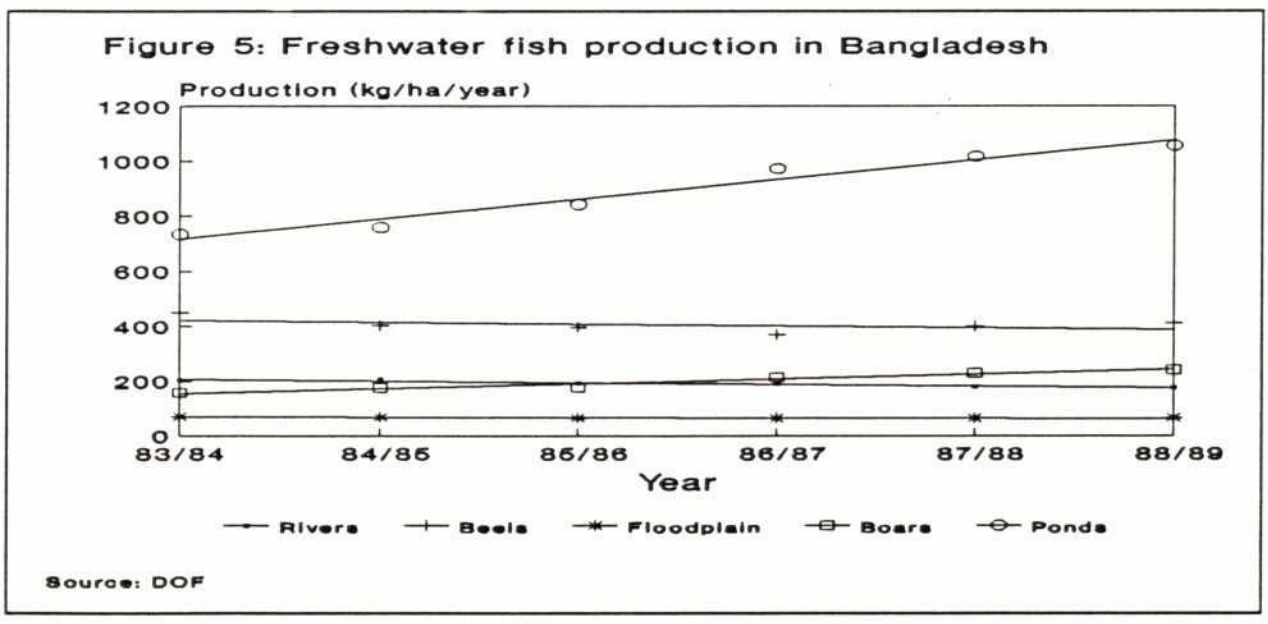
5 INLAND FISHERIES STATISTICS

A Bangladesh

5.1 The total inland fish production obtained through fisheries and aquaculture remained stable within the last decade as can be seen in Figure 4. This overall figure could be soothing but



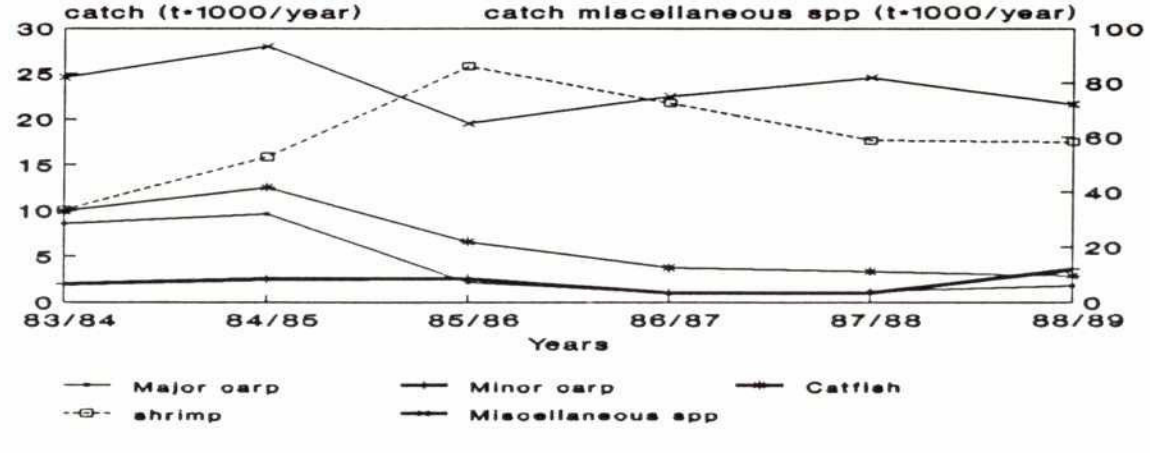
unfortunately the "fisheries" reality, when looked upon in detail, gives a warning.The annual fisheries production from rivers, floodplain and beels declined with 44.000 T during the period 1983-1989. Within the same period the aquaculture output of Bangladesh increased with 48.000 t.



5.1 Figure 5 presents the production figure on a hectare basis for Bangladesh. On a hectare basis the decline of approximately 10 % of fisheries is not spectacular. The magnitude of the area in which this takes place makes it important.
Within the last decade the decline of fisheries output within 3.8 million hectare has been compensated by a increased aquaculture output obtained from 150.000 ha ponds.
The number of ponds remained more or less stable in the last decade, but their average annual production increased from 735 kg/ha/yr, in 1983, to 1055 kg/ha/yr in 1989.
An average production of 1500-2000 kg/ha/yr should be considered as the maximum level to be possible with the actual used methods, which indicates that their is not much room left for a continuing cover-up by aquaculture.

5.2 Ali and Zaman (1989), plotted in one graph the growth of flood control and drainage and the declined floodplain catches and it figured: more FCD/I means less fish (no quantifications are given).
Such a relation does not give the "proof". However, when its is taken into account how carp depend on the floodplain in their early life and, and we look at the declined fisheries output of these species (figure 6), it makes it a "reasonable" suspicion.

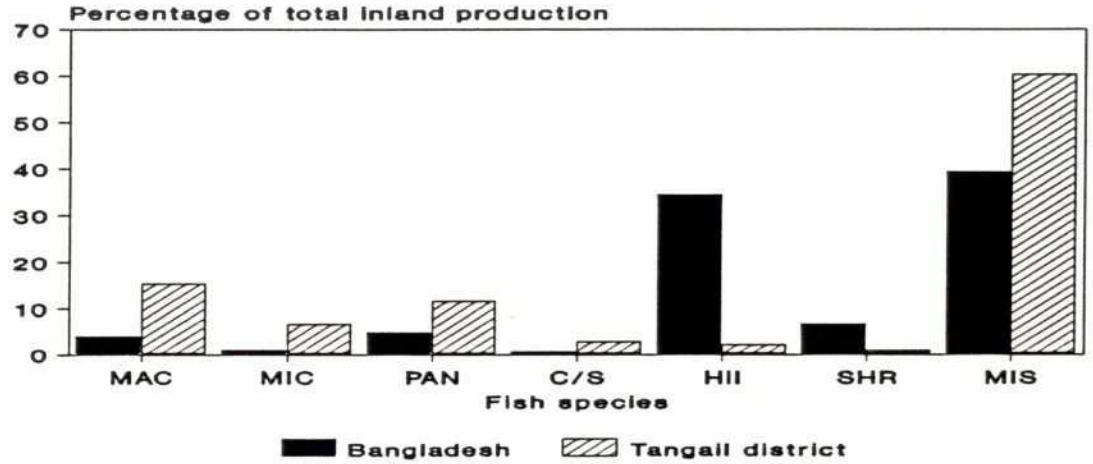
Figure 6: River catches in Bangladesh



Source: DOF

5.3 Fisheries projects in Bangladesh, are upto now mainly focusing on the high valued carps, through the improvement of aquaculture techniques or through the introduction of culture-based fisheries (stocking programs). The importance of the miscellaneous or "small" fish for consumption has been indicated before in 4.2. The importance of this group is also reflected in the catch statistics (figure 7). Approximately 40% of the total inland fish production of Bangladesh is covered by the "small" fish, this justifies the incorporation of this groups within all future development scenario's. In "economic terms" the 15 % of the major carps is probably of more importance, because of their higher "market" value. But validation on "market" value only can be questioned, and is this matter is discussed by FAP 20, FAP 17 and FAP 16.

Figure 7: Fish catches by groups in Bangladesh & Tangail



MAC: Major Carp, MIC: Minor Carp, PAN: Pangasius C/S: Catfish & snakehead, HIL: Hilsa, SHR: ShrimpsMISC: Miscellaneous spp
SOURCE: DOF

B Tangail district

5.4 Tangail district is together with Kusthia district the lowest fish producer of the whole of Bangladesh, each producing approximately 2 kg/capita/year as can be seen from Table 2.
TABLE 2: Inland fish production and availability of fish per capita in the "old" districts of Bangladesh.

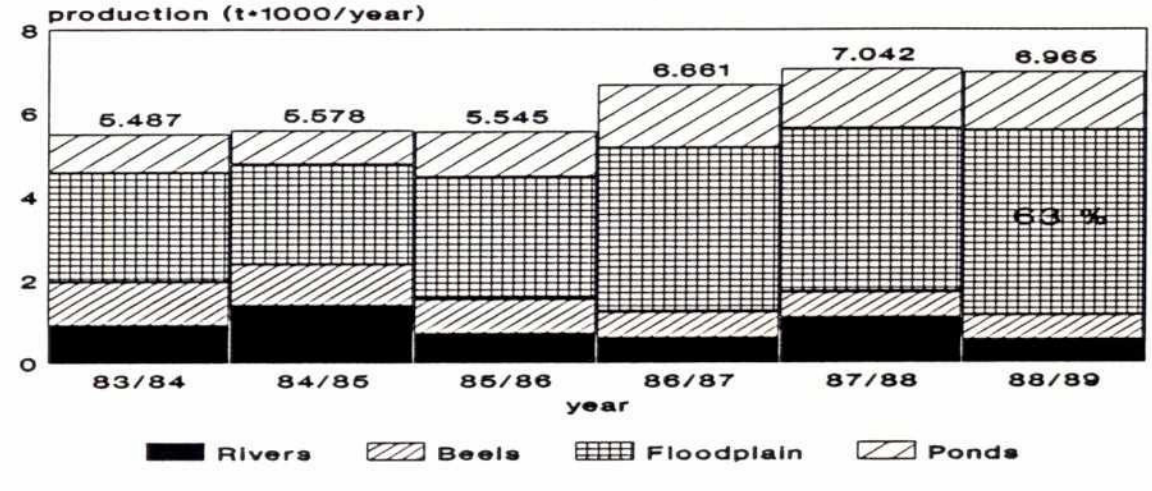
NAME OLD DISTRICT	AREA KM^2	POPULATION	NUMBER/KM^2	FISH PRODUCTION	KG/HA/YR	KG/PERSON/YR
Kusthia	3440	2754049	801	5977	17	2
Tangail	3403	2943756	865	6965	20	2
Faridpur	6882	5428044	789	13884	20	3
Dinajpur	6567	3858084	587	10346	16	3
Rangpur	9256	7780907	841	22328	24	3
Dhaka	7470	13150908	1760	38533	52	3
Pabna	4732	4106488	868	12885	27	3
Mymenshingh	9668	13692042	1416	48745	50	4
Rajshahi	9456	6384068	675	24881	26	4
Bogra	3888	3302108	849	14370	37	4
Jamalpur	3349	1871772	559	8570	26	5
Jessore	6573	4812651	732	23167	35	5
Comilla	6602	8183688	1240	59807	91	7
Noakhali	5460	4621064	846	41737	76	9
Khulna	12168	5013746	412	47531	39	9
Sylhet	12927	5447681	421	54229	42	10
Chittagong	7457	7612695	1021	77728	104	10
Patuakhalia	4078	2014497	494	22530	55	11
Barisal	7299	5371647	736	73432	101	14

Source: Statistical Yearbook of Bangladesh

As indicated in 4.3 the production and availability of fish in Tangail district is rather low. This could be due to high agricultural use of the land, the topography, the hydrology or due to sampling errors within the fisheries statistical data. The special fisheries study should clarify this problem.

5.5 In Tangail district, the main source of fish is: River fisheries, Beel fisheries, Floodplain fisheries and Aquaculture. The production levels are presented in figure 8.

Figure 8: Freshwater fish production in Tangail district



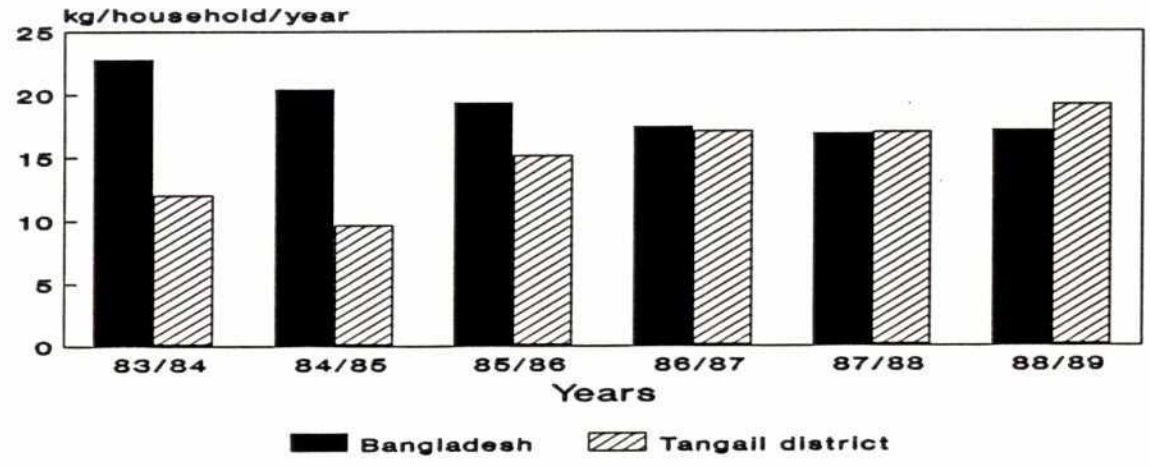
Source: DOF

The total fish production of Tangail district increased from 5.487 t/yr in 1983 to 6.965 t/yr in 1989, mainly due to an increased floodplain fisheries output. Both river and beel fisheries declined within the last decade.

5.6 Subsistence catches from the floodplain covered 63%[5] of the total inland fish production in 1988 of Tangail district, which is substantial more then the average 32 % for the whole of Bangladesh (see fig 4).
The situation on subsistence catches in the Tangail district is particular, as can be seen in figure 9 and 10. The subsistence catch for the whole of Bangladesh declined from 24 kg/household/year in 1983 to 18 kg/household/year in 1989. In the Tangail district the opposite takes place, an increase from 13 kg/household/year in 1983 to 19 kg/household/year in 1989. In both cases the relative number of households which are engaged in subsistence fisheries remained stable at 50-60 %. At present it is assumed that the difference exists due to errors in data collection and clarification should come from the special fisheries study.

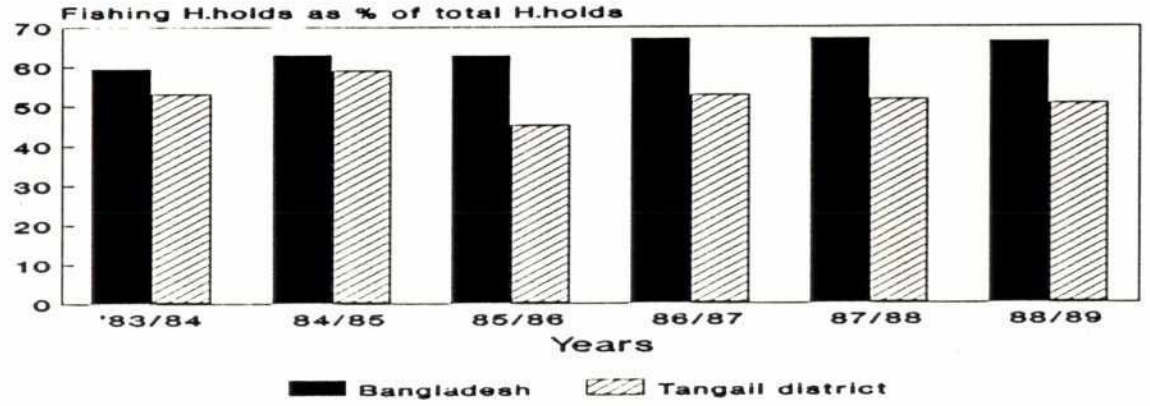
[5] Flood plain fisheries comprises all species and should not be confused with the production of "small" fish.

Figure 9: Subsistence catches in Tangail district



Source DOF

Figure 10: Households and subsistence fisheries



Source: DOF

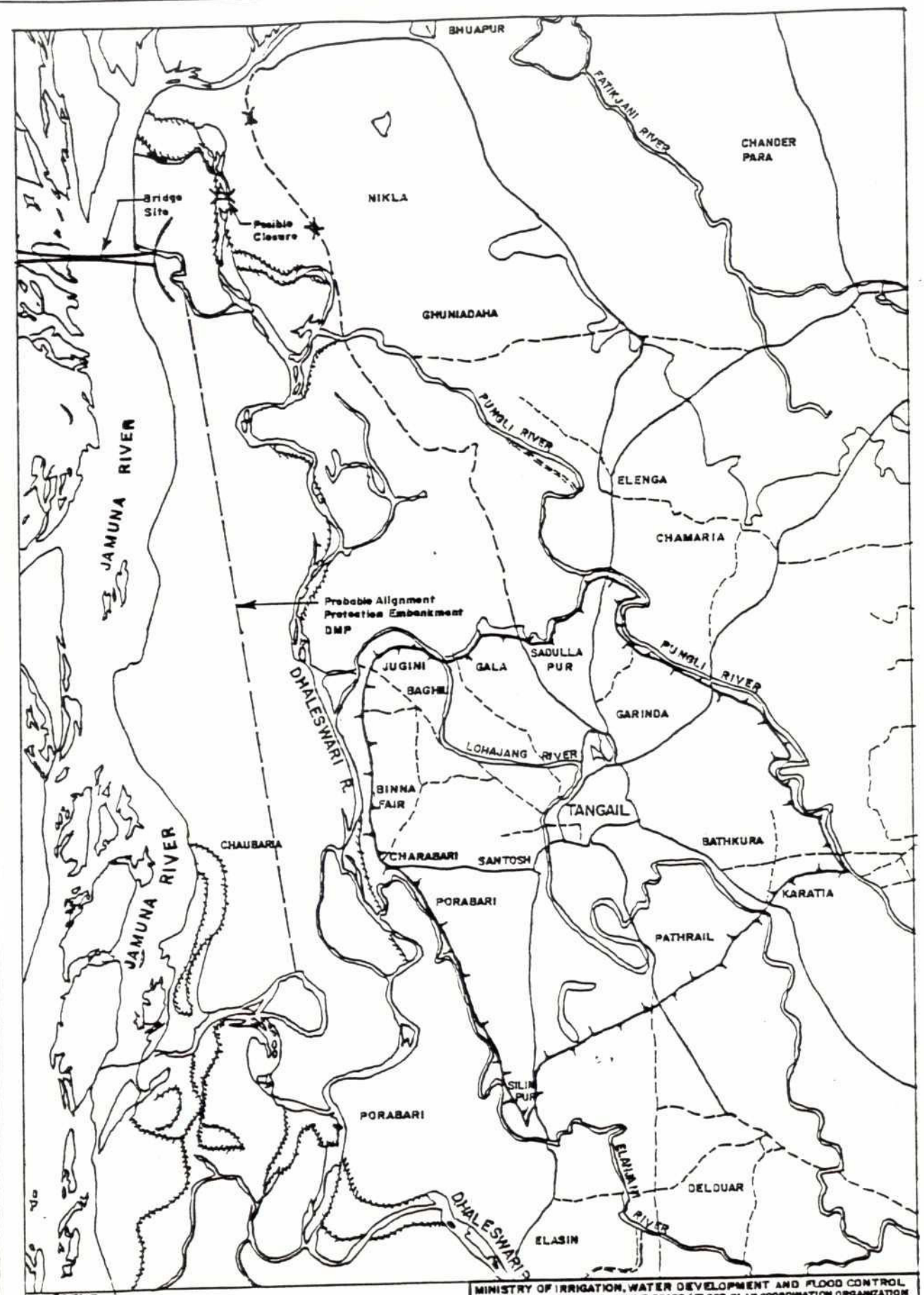

BHUAPUR
FATIKJANI RIVER
CHANDER PARA
NIKLA
Bridge Site
Possible Closure
GHUNIADAHA
JAMUNA RIVER
PUNGLI RIVER
ELENGA
CHAMARIA
Probable Alignment Protection Embankment DMP
DHALESWARI R.
JUGINI
GALA
SADULLA PUR
BAGHEL
PUNGLI RIVER
GARINDA
LOHAJANG RIVER
BINNA FAIR
TANGAIL
CHAUBARIA
CHARABARI
SANTOSH
BATHKURA
KARATIA
PORABARI
PATHRAIL
JAMUNA RIVER
SILIM PUR
PORABARI
ELANJIT RIVER
DELDUAR
DHALESWARI R.
ELASIN
LEGEND
Existing Embankment/Raised Road (Project Boundary)
Highway
Local Road
River & Khal
Bridge
MINISTRY OF IRRIGATION, WATER DEVELOPMENT AND FLOOD CONTROL
BANGLADESH WATER DEVELOPMENT BOARD/ FLOOD PLAIN COORDINATION ORGANIZATION
COMPARTMENTALIZATION PILOT PROJECT
FAP-20
CPP TANGAIL LOCATION MAP
CONSULTANTS: Euroconsult, Lahmeyer Int. Beta Ltd., HCL.
Drawn by: S.K. Rahman
Checked by: G. Kibria
Fig. no. 11

FIGURE 11

6. THE PRESENT STATUS OF FISHERIES IN THE CPP PROJECT AREA

A Introduction

6.1 Detailed information on fish stocks, catch, fishing intensity, catch per unit effort, etc for the whole of Bangladesh is limited. Such information for a confined area as the CPP project is almost impossible to find. The preliminary data/figures, given in the next chapters, are a compilation of the results of field surveys, the Fisheries Household survey, the Special Fisheries Study and data obtained from secondary sources as: reports, literature and inland fisheries statistics.

B Fisheries Resources

6.2 The Tangail Pilot Project area is located on the left bank of the Jamuna, in the vicinity of Tangail Town (see Figure 11). The area is surrounded by a horse-shoe embankment along the Dhaleswari and the Elanjani rivers in the West, the Lohajang river and Gala river in the North and the Pungli river in the East. The southern boundary is formed by an earthen road between Silumpur and Koratia. The fisheries resources can be divided in two main areas when the origin of the river floodwater is considered:

(a) **The Western plain**. The river flood water from the Daleshwari, enters the area through: the Jugini khal and the Lohajang river at the North side, Through four "regulated" khals from the Daleshwari and Elanjani river at the West side and through the Gostzabari khal in the Centre.

(b) **The Eastern plain**. The river flood water from the Pungli river enters the area through the Saddullapur Khal at the North side and flood water from the Lohajang river enters from the centre.

The Characteristics of the Main water bodies are presented in Table 3.

TABLE 3: The main water bodies in the CPP project area

EASTERN PLAIN	RIVERS		BEELS		KHALS	
	NAME	AREA ha	NAME	AREA ha	NAME	AREA ha
	Pungli	252	Darun	11.55	Gala	26
			Ghar-indha	9.89		
			Aultia	4.47		
			Paila	2.12		
			Hatila	42.65		
			Shibpur	2.12		
			Barta	3.53		
			Bhatch-anda	13.43		
			Enay-etpur	2.82		

WESTERN PLAIN	RIVERS		BEELS		KHALS	
	NAME	AREA ha	NAME	AREA ha	NAME	AREA ha
	Lohajang	202	Jugini	11.78	Juginini	7
	Daleshwari	360	Krishn-apur	9.66	Fatepur	4
	Elanjani	196	Chow-bari	6.12	Santosh	N.A.
			Ghatak-bari	7.54	Gopalpur	N.A.
			Bara	8.25	Chowbari	N.A.
			Sakrail	10.60		
			Atia Kumaria	43.13		
			Mang-alhar	4.00		
			Rampal	2.82		
			Dannya	2.12		
			Belta Rashkit	1.88		
			Baruha	5.42		
			Kon-abari	10.13		
			Subki	3.53		
			Garail	5.89		
			Bajitpur	5.65		
			Bara Kum	3.53		
			Sidker Kum	1.88		
			Kazipur	2.82		
			Ag Betair	1.41		
			Pach Betair	3.06		

Source: This study

figure 12 beel distribution over the CPP area

6.3 The "Beel"/"Floodplain" system is a highly dynamic complex. In the pre-monsoon the "Beels" are expanding due to rainwater congestion. Once the river flood enters the system, the "Beels" are expanding rapidly and are becoming part of the "Floodplain". In the post monsoon the "Floodplain" area decrease rapidly, once the water recedes toward the rivers. At a certain moment the waterlevel in the "Floodplain" becomes to low for further drainage in the river and the "Floodplain" is called "Beel" again. During the dry season the area of the "Beels" increases further due to evaporation and water use and some of them (seasonal "Beels" completely dry up. Due to this dynamism it is difficult to estimate the surface area of the beels, needed for comparison and prediction of fisheries production.
Table 4 presents the beel surface area in the CPP area, as measured with a planimeter (this study) and trough digitalization of aerial photography (FAP 16/FAP 19) and their distribution is presented in Figure 12.

TABLE 4: Beel surface area (ha) in the CPP project area.

BEEL TYPE	MEASURED BEEL AREA IN HA		
	THIS STUDY	FAP 16/FAP 19	
		MARCH	DECEMBER
SEASONAL BEELS	110	0	166
PERENNIAL BEELS	141	133	274

C Fish migration

6.4 The reproduction and migration of fish follows the general pattern as described in 3.4.

(a) **"River" fish**, as the major carps, reproduces upstream in the Jamuna river at the beginning of the rainy season. The eggs, larvae, fingerlings and adults of these species are flowing downstream with the water current into the Daleshwari and Pungli River, finally entering the floodplains the project area from the North side, through the Lohajang river, Sadullahpur Khal and Jugini Khal at the end of June. The entrance at the West side, along the Daleshwari and Elanjani river, of the project area is more or less blocked for this kind of migration due to the existing "non-fish-friendly" regulators. The entrance on the East side, along the Pungli river, is closed by embankments.
With the receding waters the carps, migrate passively back mainly to the Lohajang river and then further southward to the Daleshwari and Jamuna river.

(b) **"Beel" Fish**, such as snakeheads (Taki), catfish (Magur), climbing perch (Koi) etc, can survive the harsh environmental conditions of the beels and pagards, during the dry seasons. They probably reproduce at the onset of the rainy season, when the water level in the rises due to rainfall. First nursing takes place in the inundated areas, adjacent to the beels: later on they disperse all over the floodplain, once the river flood water enters. With the receding waters this group, migrates back or get trapped in the low lying beels and pagards.

6.5 One of the main features within the CPP project area is that the main rivers are completely cut-off from the beels during the dry season. Consequently, a migration of "River" fish from the beels back to the river, during the pre-monsoon, is not existing. The two groups intermix once the river flood water enters the project area. Secondly it should be realised that the beels in the project are rather small as compared with the beels in Sylhet, they do not exceed 50 ha in the dry seasons.

D Fisheries

6.6 The quantity of fish in a certain water body or the "standing stock" is one of the most important figure for the development of a sustainable management strategy for fisheries.
In general it is assumed that the Maximum Sustainable Yield (MSY) of a waterbody equals 35 % of the standing stock. Upto know only one source[1] gives data on standing stocks obtained in 1977-1979. However the used methodology is not completely clear, due to the fact that the original report could not yet be traced. Table 5 presents: the standing stock data, the theoretical MSY (calculated at 35 % of standing stock) and catch data of 1983/1984.

TABLE 5; Data on standing stocks, calculated MSY and catches recorded in 1983/84

Habitat	Standing Stock Kg/Ha	MSY Kg/Ha/Yr	Catch by DOF/BFRSS[2] Kg/Ha/Yr	Catch by MPO Kg/Ha/Yr
River	390	136	201	201
Floodplain	N/A	N/A	71	37
Beel	N/A	N/A	450	450
Burrow Pit	320	112	N/A	N/A
Khal	270	95	N/A	N/A

6.7 The development of fisheries management strategies, through the determination of standing stocks is time consuming, difficult and expensive. An example of such a study in a floodplain area is the much quoted Mekong Basinwide Fisheries study effected in 1973-1975. This study indicates an average standing stock of 135 Kg/ha for the river and 65 kg/ha for the floodplain in the Mekong Delta of Vietnam. The fisheries catches (66.000 t/yr), obtained in this area are much higher then the predicted Maximum Sustainable Yield of 30.000 t/yr. One of the problems encountered during this stock assessment program was that sampled catches were much lower as the catches obtained by the fishermen, and data were extrapolated. The final report already stated that their estimates "should be regarded as a conservatif minimum based on the actual catch rather than on potential catch".

---

[1]Irrigation Fisheries Development Project, 1982. Fifth Annual (final) Report, DOF, Dhaka.

[2]The difference between the DOF and MPO estimates are due to differences of the total flooded area.

Stock assessment programs are not executed in the Special Fisheries study, analyzing the existing catch data with the traditional "Schaefer" methods is more easier to execute and less expensive.

Fishing activities within the project area can be divided:

(a) Professional fishermen

6.8 The fishermen house-hold survey indicated the existence of approximately 325 professional fishing households, with 460 active fishermen in the CPP area. Their main occupation is fishing throughout the year. During the monsoon, fishing takes place all over the flood plain, during the dry season fishing is limited to beels, pagards and some standing waters of the river. Most of the fishing in beels and pagards takes place on a sharing base due to the fact that almost all of these fishing grounds are privately owned or are claimed like that, and a traditional usufruct exists. Detailed information on the socio-economic condition of the fishermen will be given in the Household baseline report (See Annex 1.1). The following type of gears are used/owned by the professional fishermen.

TABLE 6: Gear types owned by professional fishermen in the CPP area

GEAR TYPE	CALCULATED NO OF GEARS OPERATED BY PROFESSIONAL FISHERMEN IN THE CPP AREA	% OF THE HOUSEHOLDS OWNING THE GEARTYPE
SEINE NET	98	30
GILL NET	0	0
CAST NET	240	74
SCOOP NET	7	2
LIFT NET	7	2
DRAG NET	7	2
OTHERS	20	6

Source: Household Baseline Survey FAP 20

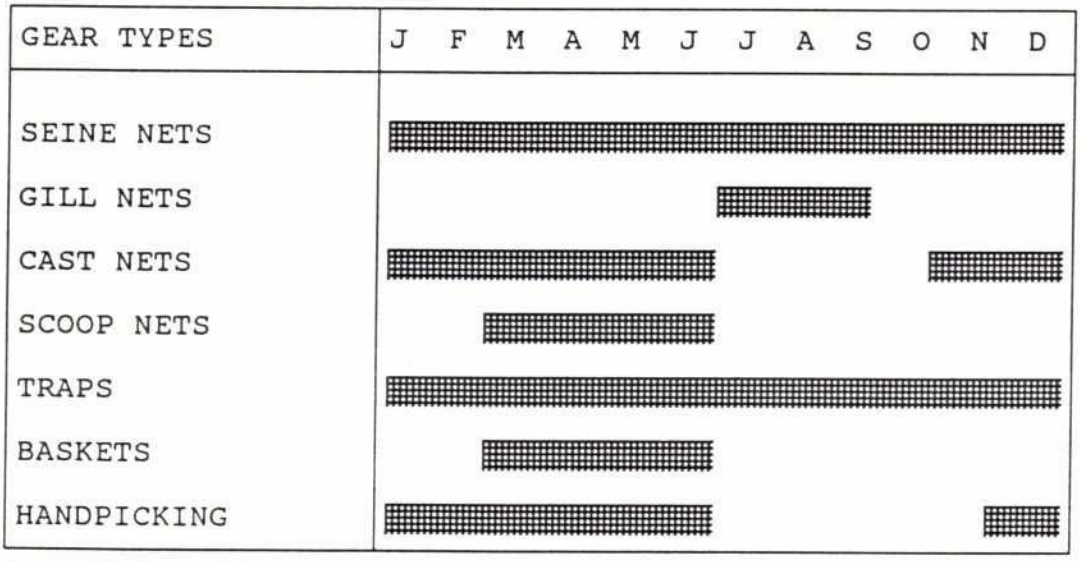
(b) Part time or Occasional fishermen

6.9 These fishermen have next to fishing an alternative occupation and are mainly using cast nets. Part time fishermen, as a separate group, are not existing in the fisheries statistics of Bangladesh. Within the first two month (may-june) of the Special Fisheries study 239 gears were analyzed, 47 % were used by professional fishermen, 32 % were used by occasional fishermen and 20 % was used by subsistence fishermen. This distribution means that approximately 930 occasional fishermen are active in the CPP area, if is assumed that occasional fishermen are fishing twice a week.

(c) Subsistence fishermen

6.10 In the majority of the households within the project area some form of fishing takes place for home consumption at some time during the year, with peaks during the monsoon. These activities can be carried out freely in the rivers and beels using scoop nets, baskets, traps, lift nets, etc. Within Tangail district their number has been estimated at 230.000[3].
For the CPP area this figure would mean 9.200 subsistence fisheries households, when an equal distribution over the whole district is assumed. The Fisheries Household Survey estimated their number at 17.290 (65% of 26.600 rural households in the CPP area).

6.11 Fisheries activities and productions are determined by the seasonal fluctuation of the flood regime. In the dry season, fishermen are operating with seine and cast nets mainly in the beels and pagards. Subsistence fisheries, using scoop nets, traps, baskets and handpicking can be carried out freely in all the beels and the majority of the fish caught this way belongs to the so called "miscellaneous" or "small" fish. During the flood period this segregation disappears and both professional, part-time and subsistence fishing is carried out freely over the floodplain. A general fishing calendar as has been observed in the CPP area is presented below.



E Estimated fish production of the CPP area

6.12 In order to estimate the total fisheries production of the CPP area the following sources were used:

(a) Catch statistics of DOF (BFRSS)
(b) Fisheries Household Survey (CPP-project)
(c) Multi Disciplinary Sub-Compartment Survey (CPP-project)
(d) The Special Fisheries Study (CPP-project)
(e) The Fisheries Consumption Study (FAP 16)

Each of the sources has its own particular aspects, which are indicated below.

---

[3]BFRSS

(a) The DOF/BFRSS figures are only available for the Tangail district area, data for the CPP area can only be obtained by assuming an equal distribution of fisheries activities over the whole district. This however is not the case, fisheries is influenced by the ecology of the area (for example; the presence of the Jamuna river), which variate in the Tangail district.On the otherhand the BFRSS-figures are more or less quantitively but are based on a relatively small number of samples.

(b) The results of the Fisheries Household Survey of FAP 20 is based on 314 samples taken in the CPP area only. the quantitive information obtained is however based on recall of information.

(c) The MDSCS of FAP 20 gives a good insight in the fisheries activities within the CPP area. However the quantitive information obtained from this survey is based on the "recall" method with relative few fishermen interviewed (See Annex 1.3).

(d) Quantitive data are available from the Special Fisheries study of FAP 20. The data are obtained through direct observation and measurement of the catch. However only data of the months May and June are available at the moment.

(e) The Fish Consumption Survey of FAP 16 can be used to cross-check the fisheries data. The data are obtained through direct observation and measurement. However also this survey is not yet completed and only data of the first months of 1992 are available.

6.13 The total fisheries output of the CPP area was estimated by using the data on fishing intensity of the subsistence households and average yearly catch of professional of the different habitats from the Household Survey, as given below in Tables 7 and 8.

TABLE 7: Intensity of subsistence fishing in the different habitats of the CPP area.

HABITAT	FARMER-FISHERMEN		NON FARMER FISHERMEN	
	% OF THE FARMERS FISHING IN THE HABITAT	NO OF CATCH DAYS	% OF THE FARMERS FISHING IN THE HABITAT	NO OF CATCH DAYS
RIVER	15.9	39.2	14.4	25.6
KHAL	20.5	31.2	14.4	38.2
BEEL	46.2	26.7	30.0	24.8
FLOODPLAIN	23.5	24.6	15.2	21.4
BURROW PIT	2.3	25.0	2.3	45.0
DERELICT POND	12.1	36.4	3.8	27.5

Source: Fisheries Household Survey, FAP 20

TABLE 8: Fish catches of professional and occasional fishermen in the different habitats of the CPP area.

HABITAT	AVERAGE CATCH KG/HOUSEHOLD/YEAR	
	PROFESSIONAL FISHERMEN	OCCASIONAL[4] FISHERMEN
RIVER	23	6
KHAL	203	51
BEEL	151	38
FLOOD PLAIN	74	18
DERELICT POND	25	6

Source: Fisheries Household Survey FAP 20

6.14 With the above given figures the total subsistence catch per habitat can be calculated by using an average catch of 0.3 kg/day per subsistence fisheries house hold. This figure lies between the 0.224 kg measured in april (see table 21) and the actual average catch of 0.5 kg measured at present by the Special Fisheries Study but is higher as the average subsistence catch consumption of approximately 0.1 kg/day measured by FAP 16 in the CPP area during the first

[4] if assumed catch occasional fishermen is 25 % of professional catch

months of 1992. the difference is probably due to the different season and the possibility that a part of the subsistence catch is sold or shared with other households.

6.15 The total fisheries production of the CPP area based on the above mentioned figure are presented in Table 9, together with an estimate based on BFRSS-data of the whole of Tangail district (CCP area equals 3.9% of Tangail district)

TABLE 9: Inland fisheries catch estimates for the CPP area.

HABITAT	CATCH IN TON/YEAR	
	THIS STUDY	BFRSS DATA
RIVER	44	20.9
BEEL	127	23.5
FLOODPLAIN	183	172
PITS & DERELICT PONDS	26	N/A
AQUACULTURE	40	55
TOTAL	420	271

The main difference is found in the production obtained from beels. This can be explained by the fact that the highest fishing intensity on subsistence level (46.2 %) takes place in the beel (see Table 7). Within the BFRSS system the beel production comes from the professional fishermen and subsistence fisheries takes place at the floodplain, which causes that fishing activities on subsistence level in the beels during the post monsoon are excluded.

7. AQUACULTURE

7.1 The decline in inland fisheries production has been compensated by an increased aquacultural production. The Fisheries Resources Survey System estimated the number of fish ponds at approximately 1.3 million, covering a total area of 147.000 ha.
Ponds are classified as:

(a) Cultured: Ponds which are artificially stocked, which have good embankments and retain water throughout the year.

(b) Culturable: Ponds which are ready for culture but have multiple ownership problems and are only stocked by nature.

(c) Derelict: Ponds which are not suitable for culture, they are to shallow, dry up in summer or need major repair.

A subdivision of the different type of ponds and their production for Bangladesh and Tangail district is given in Table 10.

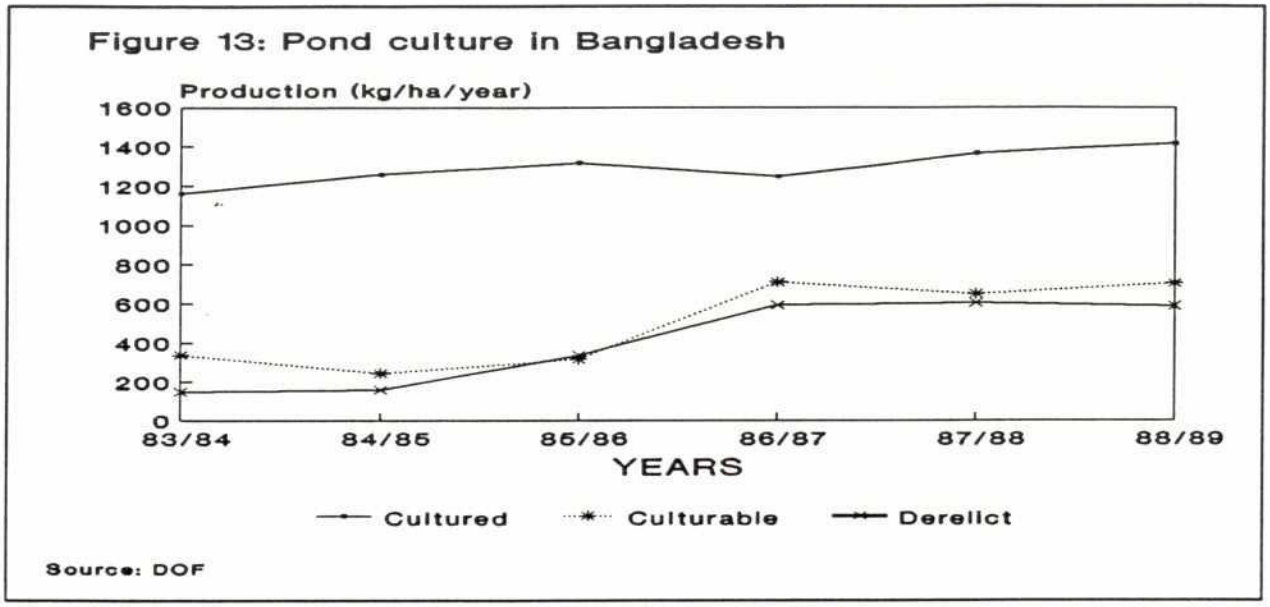
TABLE 10: The total area and production by type for Bangladesh and Tangail district as estimated in 1983/84.

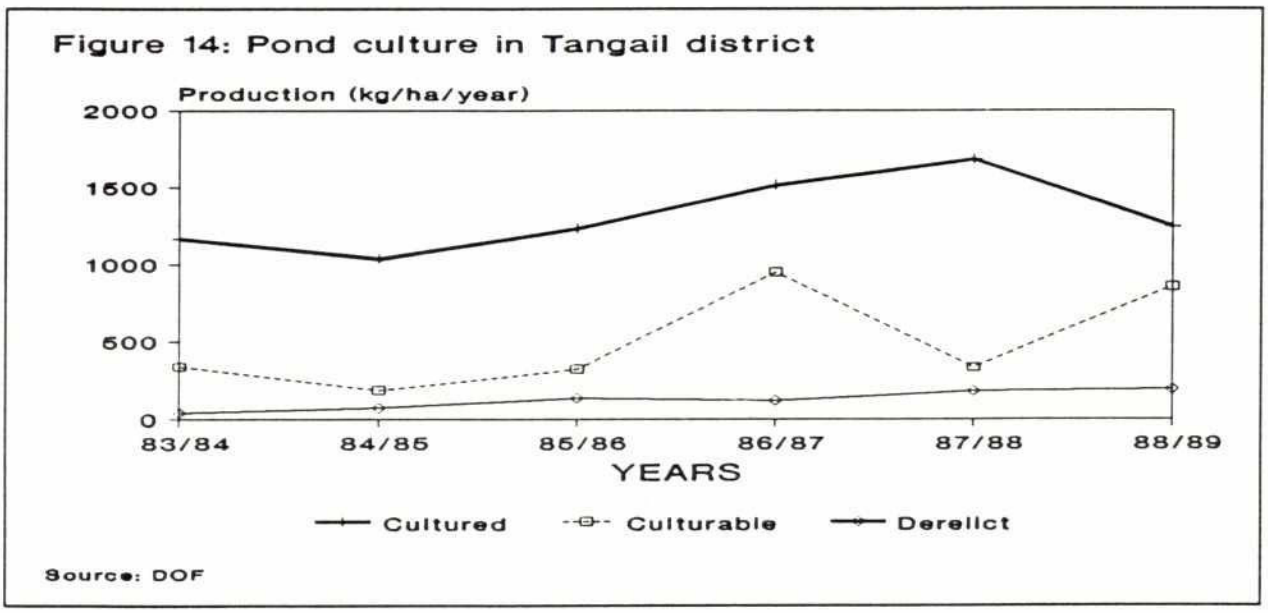
	Cultured		Culturable		Derelict	
	Area (ha)	Production (kg/ha/y)	Area (ha)	Production (kg/ha/y)	Area (ha)	Production (kg/ha/y)
Bangladesh	77754	1161	44997	338	25595	148
Tangail district	620	1161	428	338	408	148

7.2 The main species cultured in Bangladesh are: Silver carp, Common carp, Indian Carps, Grass carp and Tilapia. Fry and fingerlings are mostly obtained from natural sources, but this is gradually changing due to the fact that hatchery reared fingerlings became more and more available during the last years. The rearing techniques are simple: the fingerlings are stocked and fed agriculture by products as: rice bran and mustard seed cake.

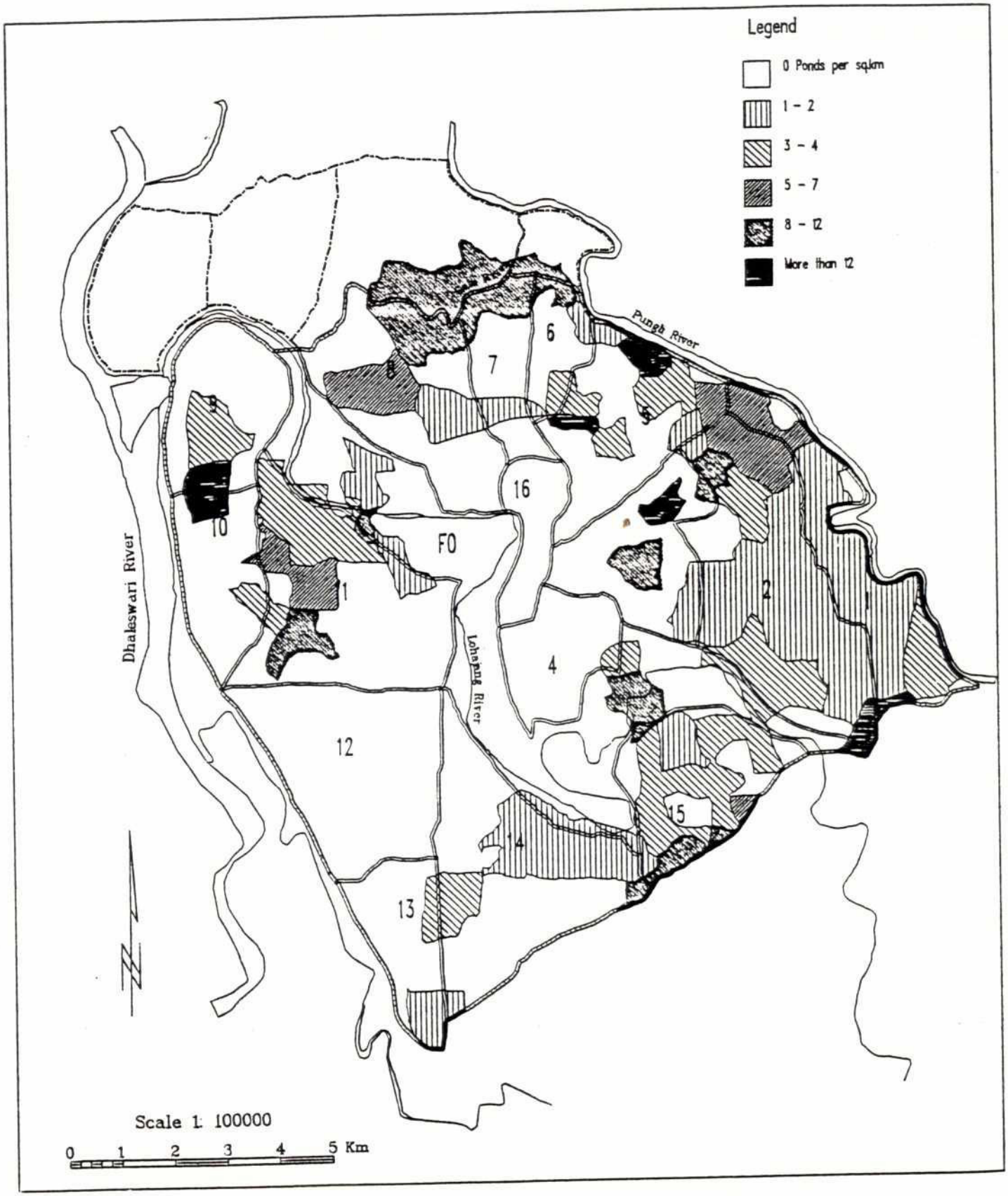
7.3 According to the statistics the number of ponds remained stable during the last decade. The incremental annual production of approximately 48.000 t has been obtained by an increased production level.

It is rather particular that a relatively large increment is obtained through the increased production of culturable and derelict ponds (see Figure 13 & 14)





7.4 A survey executed by FAP 20 in April-May 1992 indicated the existence of approximately 350 culturable ponds, within the CPP area. The distribution of these ponds within the CPP area is presented in Figure 15. The actual pond production of the CPP area is estimated at 40 ton/year, with an average pond size of 0.1 ha and a production level of 1161 kg/ha/year.



Source : FAP 19 **Figure 15: Pond distribution in the CPP Area**

Figure 15: Pond distribution in the CPP area

8. OPTIONS FOR FUTURE DEVELOPMENTS

A Introduction

8.1 At present several water management scenario"s for the project area are discussed by the CPP pilot project. In this chapter the consequences on fisheries are given for each scenario. The **theoretical** concept on the estimation of fish losses, due to different water management schemes, is well presented in the Jamalpur Priority Project Study (FAP 3.1) , Interim feasibility Report, Annex 2 Fisheries (1992). Four major effects will influence the fisheries production in a certain area;

(a) Drainage of the rain water congestion around the beels will cause a reduction of raise in water-level during the pre-monsoon. Consequently, reproduction and recruitment of "beel" fish will be hampered.

(b) Retardation of the incoming river-flood will affect the migration of carp hatchlings and adults into the floodplain.

(c) The total fish production of a floodplain is determined by its flooded area and productivity, reduction of this area will consequently leads to a reduction of the total fish production.

(d) A shortening of the inundation period will reduce the grow-out period of the carp spp, as most of them are caught when the flood recedes to the river.

8.2 Due to the fact biological information on migration, reproduction, recruitment and standing stocks is often not available for tropical floodplains, traditionally the impact of flood control has been estimated by taking only into account the changes in the inundated areas. Sometimes more factors are considered, but it often results in "estimates" becoming "guestimates".

B Methodology used in the assessment of fish losses

8.3 A three step analyses is used in the assessment of fish losses under the different scenario's:

(a) With the CPP-mathematical model of the CPP-area, the hydrological environment for the different scenario's is simulated, resulting in the total area of beels or inundated floodplain for each decade during the period of 1st May up to 31st of November. Outside this period the Floodplain/Beel area is gradually reduced to the minimum dry season level of 150 ha.

(b) A fisheries spreadsheet model was developed. This model was calibrated with the hydrological data of 1991, the floodplain/khal

fisheries production, beel fisheries production and beel fishing intensity obtained through the fisheries household survey. Within this model it is assumed that the total production from the floodplain and the khals is caught during the period of 20st of june to 10st of november, the period when floodplain/beels are connected with the river system, giving an average flood plain production of 55.3 kg/ha/year (1.535 kg/ha/decade) and the total beel production is caught in the remaining period and area. The effect of reduced inundated floodplain area (see 8.1.c) is calculated by multiplying the simulated inundated area with the estimated floodplain production of 1.535 kg/ha/decade. It is assumed that there is a linear relation ship between "beel" fish production and the available reproduction area (**which is a minimum concept**). The effect of the reduced reproduction (see 8.1.a) area for "Beel" fish is brought into the spreadsheet by taking the Beel area of the 10st of june, in the 1991 situation as a standard. A reduction of this area under the different scenario's leads to a proportional reduction in fish.

(c) In order to facilitate an economic analysis of the different scenario's, the total fish production is sub-divided species wide. The species distribution for the different habitats is obtained from the Tangail district fisheries statistics of the year 1988/1989. The used market prices are presented in annex 3. As mentioned in 5.3, using market price only, under estimates the importance of the "low valued" miscellaneous species, their nutritional value and the fact that they are the major source of animal protein for the rural poor is neglected. Unfortunately at present no other economic tools to incorporate this are available.

8.4 From the theoretical concept (8.1) only beel area reduction and inundated floodplain area reduction are used in the impact assessment. The other factors could not be included quantitively due to the following reasons:

(a) The mathematical hydrological simulations of the different scenario's indicated that the retardation of the incoming flood water is a question of days. The reproduction of carp spp and the larval densities in the major rivers of Bangladesh has a regular pattern; it starts in May and increases rapidly with a peak in June/July after which it gradually decreases to zero in september (see Figure 16). It is expected that a retardation of several days **in theory** will have a limited effect on total carp production, as long as the floodplain inundates during the high larval density period. The regulation of eventual water management however will not be easy. The hatchling curve shifts in time and they arrive in peaks as can be seen in Figure 17, which makes regulation of the intake complicated.

Figure 16: Theoretical larval densities of Carp spp in Bangladesh

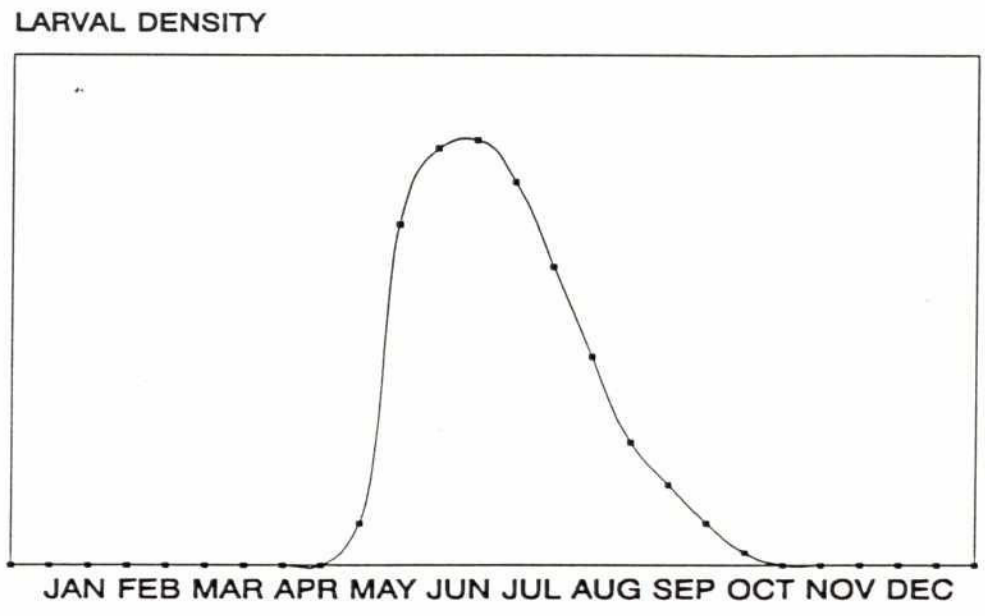
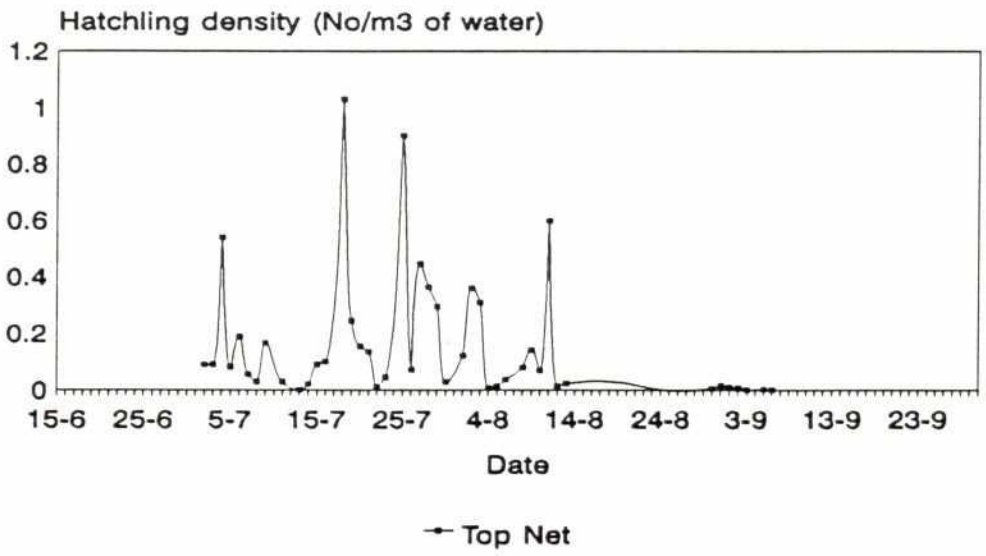


Figure 17: Hatchling density measured in 1992 in the Lohajang river



Source: Special Fisheries Study CPP-Project

(b) It is known that shallow waters are more productive as deep waters. The main reason is that primary production is higher in shallow waters due to the availability and recycling of nutrients for

photosynthesis. The Morpho Edaphic Index (MEI), in which waterdepht and fertility are expressed, has been used successfully in predicting fisheries production of large and deep waterbodies. The usefulness of the Morpho Edaphic Index for floodplain fisheries in the CPP area, as has been done in the Jamalpur priority project can be doubted. At present, base line information on floodplain fisheries production is rather scarce and information on the distribution of these figures among the different waterdepth (WL0 to WL5) is completely absent. Even if these figures are present, the interpretation will be difficult due to the fact that the floodplain is an active system, the waterdepth fluctuates over the year and that the highest fishing effort takes place in these shallow waters, resulting in a mingle of **catch** with **production** figures.

(c) A shortening of the inundation period could reduce the growth period and consequently the average size of the fish when caught. At present no information is available on the natural growth rates of the carp spp in the CPP area, even if growth rates were available, the calculation of this impact is difficult because we are dealing with a multispecies fisheries system. The hydrological model indicated that for all scenario's the water recedes to the river between 10st and the 30st of september and it can be expected that losses due to growth reduction will be marginal as most of the fish are caught during this backwards migration.

C Scenario 1; the existing situation of 1991

8.5 The production figures under existing or 1991 situation are presented in Table 11 and (more details are presented in Appendix 3).

Table 11: Total fish production of the CPP-area under scenario 1

SPECIES	PRODUCTION IN TON/YEAR						
	PRINCIPAL RIVERS	MINOR RIVERS	BEEL	FLOOD-PLAIN	PONDS	PITS & DER PONDS	TOTAL
MAJOR CARP	0,6	0,9	10,7	4,0	6,6	0,6	23,4
MINOR CARP	0,6	0,1	10,9	0,0	13,3	0,0	24,9
CATFISH	0,3	0,1	15,9	17,6	3,7	2,5	40,1
LIVE FISH	0,0	0,6	7,9	5,3	4,6	0,8	19,3
HILSA	7,0	0,0	0,0	0,0	0,0	0,0	7,0
MACRO-BRACHI-UM	0,0	0,0	0,0	0,0	0,0	0,0	0,0
SMALL SHRIMP	3,2	0,3	4,8	0,0	0,0	0,0	8,3
MISCELLA NEOUS	18,2	12,1	76,8	156,1	11,8	22,2	297
TOTAL	30	14	127	183	40	26	420

The total production under scenario 1, the existing situation of 1991 is estimated at 420 Ton/year, representing a value of 211 lakh (541.000 US$).

D Scenario 2; Improved drainage

8.6 Improved drainage by excavating the existing khals will have as an effect that: the early rainwater will be drained of in the pre-monsoon and that river flood water will disappear more quicker. There will be a negative impact on fisheries because beel and floodplain area will disappear. Aquaculture is not expected to be influenced by this measure.
Excavation of the existing khals will not result in an increased production of the carp spp, as is expected by the people in the CPP-area. The main reason for the declined carp production in the CPP area is the reduced availability of carp hatchlings in the major river systems, upstream the project area. Excavation of the khals will result in an earlier inundation of the floodplain. It should be realized that this is more a matter of days then weeks, resulting in an equal influx of carp hatchlings, as compared with the existing situation (see Figures 16 & 17). The production figures under scenario 2, improved drainage, are presented in Table 12 and (more details are presented in Appendix 3).

Table 12: Total fish production of the CPP-area under scenario 2

SPECIES	PRODUCTION IN TON/YEAR						
	PRINCIPAL RIVERS	MINOR RIVERS	BEEL	FLOOD-PLAIN	PONDS	PITS & DER PONDS	TOTAL
MAJOR CARP	0,6	0,9	7.4	3.8	6,6	0,6	19.9
MINOR CARP	0,6	0,1	7.6	0,0	13,3	0,0	21.5
CATFISH	0,3	0,1	11.0	16.7	3,7	2,5	34.5
LIVE FISH	0,0	0,6	5.5	5,0	4,6	0,8	16.6
HILSA	7,0	0,0	0.0	0,0	0,0	0,0	7,0
MACRO-BRACHI-UM	0,0	0,0	0,0	0,0	0,0	0,0	0,0
SMALL SHRIMP	3,2	0,3	3.3	0,0	0,0	0,0	6.8
MISCEL-LANEOUS	18,2	12,1	53.2	148.4	11,8	22,2	267.5
TOTAL	30	14	88	174	40	26	372

The total production under scenario 2, improved drainage, is estimated at 372 Ton/year, representing a value of 186 lakh (478.000 US$).

E Scenario 3: Main inlet in the Lohajang river at pk 4 gated with 8 vents of 5'x 10' and 3 medium sized structures at the river/floodplain interface at Khordajugini, Sadullapur and Rassulpur, combined with improved drainage

8.7 The aim of this scenario is active control over the water level within the CPP-area. The gates will be closed when the water level at the gate corresponds to an approximately 50% flooded area. This reduction in inundated floodplain area will consequently lead to losses in floodplain fisheries production. The improved drainage will result in a reduction of spawning places for "beel" fish, leading to lower recruitment and production.
The production figures under scenario 3, gated inlets and improved drainage, are presented in Table 13 and (more details are presented in Appendix 3).

TABLE 13: Total fish production of the CPP-area under scenario 3

SPECIES	PRODUCTION IN TON/YEAR						
	PRINCIPAL RIVERS	MINOR RIVERS	BEEL	FLOOD-PLAIN	PONDS	PITS & DER PONDS	TOTAL
MAJOR CARP	0,6	0,9	6.3	2.8	6,6	0,6	17.7
MINOR CARP	0,6	0,1	6.4	0,0	13,3	0,0	20.4
CATFISH	0,3	0,1	9.4	12.1	3,7	2,5	28.1
LIVE FISH	0,0	0,6	4.7	3.7	4,6	0,8	14.7
HILSA	7,0	0,0	0.0	0,0	0,0	0,0	7,0
MACRO-BRACHI-UM	0,0	0,0	0,0	0,0	0,0	0,0	0,0
SMALL SHRIMP	3,2	0,3	2.8	0,0	0,0	0,0	6.3
MISCELLA NEOUS	18,2	12,1	45.3	107.5	11,8	22,2	217.0
TOTAL	30	14	75	126	40	26	311

The total production under scenario 3, is estimated at 311 ton/year, representing a value of 157 lakh (402.000 US$).

F Scenario 4: Main inlet in the Lohajang river gated at pk 4 with 4 vents of 5'x 10' and 3 medium sized structures at the river/floodplain interface at Kordajugini, Sadullapur and Rassulpur, combined with improved drainage

8.8 The aim of this scenario is active control over the water level within the CPP-area. The gates will be closed when the water level at the gate corresponds to an approximately 50% flooded area. This reduction in inundated floodplain area will consequently lead to losses in floodplain fisheries production. The improved drainage will result in a reduction of spawning places for "beel" fish, leading to lower recruitment and production.
The production figures under scenario 4, gated inlets and improved drainage, are presented in Table 14 and (more details are presented in Appendix 3).

TABLE 14: Total fish production of the CPP-area under scenario 4

SPECIES	PRODUCTION IN TON/YEAR						
	PRINCIPAL RIVERS	MINOR RIVERS	BEEL	FLOOD-PLAIN	PONDS	PITS & DER PONDS	TOTAL
MAJOR CARP	0,6	0,9	5.0	2.5	6,6	0,6	16.1
MINOR CARP	0,6	0,1	5.1	0,0	13,3	0,0	19.1
CATFISH	0,3	0,1	7.4	10.8	3,7	2,5	24.9
LIVE FISH	0,0	0,6	3.7	3.3	4,6	0,8	13.0
HILSA	7,0	0,0	0.0	0,0	0,0	0,0	7,0
MACRO-BRACHI-UM	0,0	0,0	0,0	0,0	0,0	0,0	0,0
SMALL SHRIMP	3,2	0,3	2.2	0,0	0,0	0,0	5.7
MISCELLA NEOUS	18,2	12,1	35.7	96.4	11,8	22,2	196.3
TOTAL	30	14	59	113	40	26	282

The total production under scenario 4, is estimated at 282 ton/year, representing a value of 142 lakh (365.000 US$).

G Scenario 5; Main inlet of the Lohajang river at pk 4 throttled and river/floodplain interface closed medium sized throttled inlets at Kordajugini, Sadullapur and Rassulpur, combined with improved drainage

8.9 The aim of this scenario is passive control over the water level within the CPP-area without obstructing the drainage during the pre and post monsoon. There will be reduction in inundated floodplain area and this consequently leads to losses in floodplain fisheries production. The improved drainage will result in a reduction of spawning places for "beel" fish, leading to lower recruitment and production.
The production figures under scenario 5, throttled inlets and improved drainage, are presented in Table 15 and (more details are presented in Appendix 3).

TABLE 15: Total fish production of the CPP-area under scenario 5

SPECIES	PRODUCTION IN TON/YEAR						
	PRINCIPAL RIVERS	MINOR RIVERS	BEEL	FLOOD-PLAIN	PONDS	PITS & DER PONDS	TOTAL
MAJOR CARP	0,6	0,9	6.4	3.4	6,6	0,6	18.5
MINOR CARP	0,6	0,1	6.5	0,0	13,3	0,0	20.5
CATFISH	0,3	0,1	9.5	15.0	3,7	2,5	31.1
LIVE FISH	0,0	0,6	4.8	4.5	4,6	0,8	15.3
HILSA	7,0	0,0	0.0	0,0	0,0	0,0	7,0
MACRO-BRACHI-UM	0,0	0,0	0,0	0,0	0,0	0,0	0,0
SMALL SHRIMP	3,2	0,3	2.9	0,0	0,0	0,0	6.4
MISCE-LLAN-EOUS	18,2	12,1	45.9	133.1	11,8	22,2	243.2
TOTAL	30	14	76	156	40	26	342

The total production under scenario 5, is estimated at 342 ton/year, representing a value of 171 lakh (440.000 US$).

H Scenario 6: Main inlet in the Lohajang river at pk 4 gated with 8 vents of 5'x 10' and 3 medium sized structures at the river/floodplain interface at Khordajugini, Sadullapur and Rassulpur, a 8 vent outlet regulator in the Lohajang river at pk 30 near Karotia, combined with improved drainage

8.10 The aim of this scenario is active control over the water level within the CPP-area. the gates will be closed when the water level at the gate corresponds to an approximately 50% flooded area. This reduction in inundated floodplain area will consequently lead to losses in floodplain fisheries production. The improved drainage will result in a reduction of spawning places for "beel" fish, leading to lower recruitment and production. However instead of a reduction of beel area during the May/June, the hydrological model indicates an increased area, which leads consequently to an surplus "beel" fish production. The initialisation of the model started with to high water levels.
The preliminary production figures under scenario 6, gated inlets and improved drainage, are presented in Table 16 and (more details are presented in Appendix 3).

TABLE 16: Total fish production of the CPP-area under scenario 6

SPECIES	PRODUCTION IN TON/YEAR						
	PRINCIPAL RIVERS	MINOR RIVERS	BEEL	FLOOD-PLAIN	PONDS	PITS & DER PONDS	TOTAL
MAJOR CARP	0,6	0,9	21.3	3.2	6,6	0,6	33.2
MINOR CARP	0,6	0,1	21.8	0,0	13,3	0,0	35.8
CATFISH	0,3	0,1	31.9	13.9	3,7	2,5	52.4
LIVE FISH	0,0	0,6	15.9	4.2	4,6	0,8	26.1
HILSA	7,0	0,0	0.0	0,0	0,0	0,0	7,0
MACRO-BRACHI-UM	0,0	0,0	0,0	0,0	0,0	0,0	0,0
SMALL SHRIMP	3,2	0,3	9.6	0,0	0,0	0,0	13.1
MISCE-LLAN-EOUS	18,2	12,1	153.5	123.7	11,8	22,2	341.4
TOTAL	30	14	254	145	40	26	509

The total production under scenario 6, is estimated at 509 ton/year, representing a value of 200 lakh (514.000 US$) but should be considered as not realistic.

I **Scenario 7: Main inlet in the Lohajang river at pk 1 gated with 8 vents of 5'x 10' and 4 medium sized structures at the river/floodplain interface at Malancho,Choto Basalla, Bara Basalia and Char Durgapur, combined with improved drainage**

8.11 This scenario could be considered as an extended project area. The aim of this scenario is active control over the water level within the CPP-area. The gates will be closed when the water level at the gate corresponds to an approximately 50% flooded area. This reduction in inundated floodplain area will consequently lead to losses in floodplain fisheries production. The improved drainage will result in a reduction of spawning places for "beel" fish, leading to lower recruitment and production.
The production figures under scenario 7, extended project area and gated inlets, are presented in Table 17 and (more details are presented in Appendix 3).

TABLE 17: Total fish production of the CPP-area under scenario 7

SPECIES	PRODUCTION IN TON/YEAR						
	PRINCIPAL RIVERS	MINOR RIVERS	BEEL	FLOOD-PLAIN	PONDS	PITS & DER PONDS	TOTAL
MAJOR CARP	0,6	0,9	7.1	2.8	6,6	0,6	18.6
MINOR CARP	0,6	0,1	7.3	0,0	13,3	0,0	21.3
CATFISH	0,3	0,1	10.7	12.2	3,7	2,5	29.5
LIVE FISH	0,0	0,6	5.3	3.7	4,6	0,8	15.0
HILSA	7,0	0,0	0.0	0,0	0,0	0,0	7,0
MACRO-BRACHI-UM	0,0	0,0	0,0	0,0	0,0	0,0	0,0
SMALL SHRIMP	3,2	0,3	3.2	0,0	0,0	0,0	6.7
MISCE-LLAN-EOUS	18,2	12,1	51.4	108	11,8	22,2	223.9
TOTAL	30	14	85	127	40	26	322

The total production under scenario 7, is estimated at 322 ton/year, representing a value of 163 lakh (417.000 US$).

J Scenario 8; Main inlet of the Lohajang river at pk 4 throttled and river/floodplain interface closed with 8 medium sized throttled inlets , combined with improved drainage

8.12 The aim of this scenario is passive control over the water level within the CPP-area without obstructing the drainage during the pre and post monsoon. There will be reduction in inundated floodplain area and this consequently leads to losses in floodplain fisheries production. The improved drainage will result in a reduction of spawning places for "beel" fish, leading to lower recruitment and production.
The production figures under scenario 8, are presented in Table 18 (more details are presented in Appendix 3).

TABLE 18: Total fish production of the CPP-area under scenario 8

SPECIES	PRODUCTION IN TON/YEAR						
	PRINCIPAL RIVERS	MINOR RIVERS	BEEL	FLOOD-PLAIN	PONDS	PITS & DER PONDS	TOTAL
MAJOR CARP	0,6	0,9	7.1	3.3	6,6	0,6	19.1
MINOR CARP	0,6	0,1	7.3	0,0	13,3	0,0	21.3
CATFISH	0,3	0,1	10.7	14.2	3,7	2,5	31.5
LIVE FISH	0,0	0,6	5.3	4.3	4,6	0,8	15.6
HILSA	7,0	0,0	0.0	0,0	0,0	0,0	7,0
MACRO-BRACHI-UM	0,0	0,0	0,0	0,0	0,0	0,0	0,0
SMALL SHRIMP	3,2	0,3	3.2	0,0	0,0	0,0	6.7
MISCE-LLAN-EOUS	18,2	12,1	51.4	126.2	11,8	22,2	241.8
TOTAL	30	14	85	148	40	26	343

The total production under scenario 8, is estimated at 343 ton/year, representing a value of 172 lakh (442.000 US$).

K Scenario 9; Peripherial control through regulators placed in the main inlet of the Lohajang river and medium size inlets at Korda Jugini, Sadullahpur and Rasulpur combined with improvement of the four regulators along the Dhaleshwari and Elanjani river. All regulators are based on overspill

8.13 The aim of this scenario is active control over the water level within the CPP-area without obstructing the drainage during the pre and post monsoon. There will be reduction in inundated floodplain area and this consequently leads to losses in floodplain fisheries production. The improved drainage will result in a reduction of spawning places for "beel" fish, leading to lower recruitment and production. The use of water regulators based on the overspill of water are considered to be more or less "fish friendly" and marginal mortality is expected to occur when carp hatchlings are passing.
The production figures under scenario 9, are presented in Table 18 (more details are presented in Appendix 3).

TABLE 19: Total fish production of the CPP-area under scenario 9

SPECIES	PRODUCTION IN TON/YEAR						
	PRINCIPAL RIVERS	MINOR RIVERS	BEEL	FLOOD-PLAIN	PONDS	PITS & DER PONDS	TOTAL
MAJOR CARP	0,6	0,9	7.7	3.8	6,6	0,6	20.2
MINOR CARP	0,6	0,1	7.9	0,0	13,3	0,0	21.9
CATFISH	0,3	0,1	11.5	16.4	3,7	2,5	34.6
LIVE FISH	0,0	0,6	5.8	5.0	4,6	0,8	16.7
HILSA	7,0	0,0	0.0	0,0	0,0	0,0	7,0
MACRO-BRACHI-UM	0,0	0,0	0,0	0,0	0,0	0,0	0,0
SMALL SHRIMP	3,2	0,3	3.5	0,0	0,0	0,0	7.0
MISCE-LLAN-EOUS	18,2	12,1	55.6	145.9	11,8	22,2	265.7
TOTAL	30	14	92	171	40	26	373

The total production under scenario 9, is estimated at 373 ton/year, representing a value of 170 lakh (436.000 US$).

L **Scenario 10; Peripherial control and Internal control through regulators placed in the main inlet of the lohajang river, medium size inlets at Korda Jugini, Sadullahpur and Rasulpur and minor structures in Bally, Binnafair, Gazibari, Deojan, Kumuli, Jalfai and Bhatkura combined with improvement of the four regulators along the Dhaleshwari and Elanjani river. All regulators are based on overspill**

8.14 The aim of this scenario is active control over the water level within the CPP-area including control at subcompartment level. There will be reduction in inundated floodplain area and this consequently leads to losses in floodplain fisheries production. The improved drainage will result in a reduction of spawning places for "beel" fish, leading to lower recruitment and production. The use of water regulators based on the overspill of water are considered to be more or less "fish friendly" and marginal mortality is expected to occur when carp hatchlings are passing.
The production figures under scenario 10, are presented in Table 20 (more details are presented in Appendix 3).

TABLE 20 : Total fish production of the CPP-area under scenario 9

SPECIES	PRODUCTION IN TON/YEAR						
	PRINCIPAL RIVERS	MINOR RIVERS	BEEL	FLOOD-PLAIN	PONDS	PITS & DER PONDS	TOTAL
MAJOR CARP	0,6	0,9	5.1	3.5	6,6	0,6	17.3
MINOR CARP	0,6	0,1	5.2	0,0	13,3	0,0	19.2
CATFISH	0,3	0,1	7.7	15.3	3,7	2,5	29.5
LIVE FISH	0,0	0,6	3.8	4.6	4,6	0,8	14.4
HILSA	7,0	0,0	0.0	0,0	0,0	0,0	7
MACRO-BRACHI-UM	0,0	0,0	0,0	0,0	0,0	0,0	0,0
SMALL SHRIMP	3,2	0,3	2.3	0,0	0,0	0,0	5.8
MISCE-LLAN-EOUS	18,2	12,1	36.9	135.6	11,8	22,2	236.7
TOTAL	30	14	61	159	40	26	330

The total production under scenario 10, is estimated at 330 ton/year, representing a value of 165 lakh (423.000 US$).

M **Scenario 11; Peripherial control through regulators placed in the main inlet of the lohajang river and medium size inlets at Korda Jugini, Sadullahpur and Rasulpur combined with improvement of the four regulators along the Dhaleshwari and Elanjani river. 50 % of the water enters through overspill and 50 % and 50 % through undershot**

8.15 The aim of this scenario is active control over the water level within the CPP-area without obstructing the drainage during the pre and post monsoon. There will be reduction in inundated floodplain area and this consequently leads to losses in floodplain fisheries production. The improved drainage will result in a reduction of spawning places for "beel" fish, leading to lower recruitment and production. Regulators based on the under shot principle are cheaper and simpler to construct the overspill regulators. Under shot however results in pressure and whirling of the tiny carp hatchling and a mortality rate of 80 % can be expected.
The production figures under scenario 11, are presented in Table 21.

TABLE 21: Total fish production of the CPP-area under scenario 11

SPECIES	PRODUCTION IN TON/YEAR						
	PRINCIPAL RIVERS	MINOR RIVERS	BEEL	FLOOD-PLAIN	PONDS	PITS & DER PONDS	TOTAL
MAJOR CARP	0,6	0,5	4.6	2.3	6,6	0,3	15.5
MINOR CARP	0,6	0	4.7	0,0	13,3	0,0	18.7
CATFISH	0,3	0,1	11.5	16.4	3,7	2,5	34.6
LIVE FISH	0,0	0,6	5.8	5.0	4,6	0,8	16.7
HILSA	7,0	0,0	0.0	0,0	0,0	0,0	7,0
MACRO-BRACHI-UM	0,0	0,0	0,0	0,0	0,0	0,0	0,0
SMALL SHRIMP	3,2	0,3	3.5	0,0	0,0	0,0	7.0
MISCE-LLAN-EOUS	18,2	12,1	55.6	145.9	11,8	22,2	265.7
TOTAL	30	14	86	169	40	26	365

The total production under scenario 11, is estimated at 365 ton/year, representing a value of 164 lakh (419.000 US$).

N **Scenario 12; Peripherial control and Internal control through regulators placed the main inlet of the lohajang river, medium size inlets at Korda Jugini, Sadullahpur and Rasulpur and minor structures in Bally, Binnafair, Gazibari, Deojan, Kumuli, Jalfai and Bhatkura combined with improvement of the four regulators along the Dhaleshwari and Elanjani river. 50 % of the water enters through overspill and 50 % and 50 % through undershot**

8.16 The aim of this scenario is active control over the water level within the CPP-area including control at subcompartment level. There will be reduction in inundated floodplain area and this consequently leads to losses in floodplain fisheries production. The improved drainage will result in a reduction of spawning places for "beel" fish, leading to lower recruitment and production. Regulators based on the under shot principle are cheaper and simpler to construct the overspill regulators. Under shot however results in pressure and whirling of the tiny carp hatchling and a mortality rate of 80 % can be expected.
The production figures under scenario 12, are presented in Table 22 (more details are presented in Appendix 3).

TABLE 22 : Total fish production of the CPP-area under scenario 12

SPECIES	PRODUCTION IN TON/YEAR						
	PRINCIPAL RIVERS	MINOR RIVERS	BEEL	FLOOD-PLAIN	PONDS	PITS & DER PONDS	TOTAL
MAJOR CARP	0,6	0,9	3.1	2.1	6,6	0,6	17.3
MINOR CARP	0,6	0,1	3.1	0,0	13,3	0,0	19.2
CATFISH	0,3	0,1	7.7	15.3	3,7	2,5	29.5
LIVE FISH	0,0	0,6	3.8	4.6	4,6	0,8	14.4
HILSA	7,0	0,0	0.0	0,0	0,0	0,0	7
MACRO-BRACHI-UM	0,0	0,0	0,0	0,0	0,0	0,0	0,0
SMALL SHRIMP	3,2	0,3	2.3	0,0	0,0	0,0	5.8
MISCE-LLAN-EOUS	18,2	12,1	36.9	135.6	11,8	22,2	236.7
TOTAL	30	14	57	158	40	26	324

The total production under scenario 12, is estimated at 324 ton/year, representing a value of 162 lakh (414.000 US$).

O Summary and conclusion

8.17 A summary of the impact assessment for the different scenario's is presented below,in Table 23:

TABLE 23: A summary of the impact assessment for the different scenario's.

SCENARIO	TOTAL FISH PRO-DUCTION T/YEAR	DECREMEN TAL PRO-DUCTION T/YEAR	TOTAL VALUE (US$/YEAR)	DECREME-NTAL VALUE (US$/YEAR)
1: existing situation	420		541.000	
2: drainage	372	-48	478.000	-63.000
3: large gated inlets	311	-109	402.000	-139.000
4: small gated inlets	282	-138	365.000	176.000
5: 4 throttled inlets	342	-78	440.000	-101.000
6: gated inlets and outlets	N.A.	N.A.	N.A.	N.A.
7: expanded project area	324	-96	417.000	-124.000
8: 9 throttled inlets	343	-77	442.000	-99.000
9: peripheral control overspill only	373	-47	436.000	-105.000
10: peripheral & internal, overspill only	330	-90	423.000	-118.000
11: peripheral control overspill 50% undershot 50%	365	-55	419.000	-122.000
12: peripheral & internal, overspill 50%, undershot 50%	324	-96	414.000	-127.000

All scenario's have a negative impact on fisheries production within the CPP-area. The losses are in the range of 9.9 % to 33.9 %, were the highest estimates are found in the more sophisticated water management schemes. The limited effect of fish friendly regulators is caused by the fact that the percentage of carp in the total catch is small. The main cause of the decreased carp catch is outside the project area; destroyed breeding habitats and fry fishing in the big rivers upstreams and should be further investigated by FAP 17.

9. MITIGATION

9.1 A decline of the fisheries production, even a small one, must be considered very carefully, as fish is the main source of animal protein of the rural society. Where possible mitigation should introduced in order to replace the losses. The integrated farming of rice/fish, culture based fisheries and the construction of "fish-friendly" regulators could be considered. It is an illusion however to expect that these measures can replace completely the losses of natural fisheries.

A Integrated farming of Rice/Fish.

9.2 In general the different integrated types of rice/fish production can be classified as follows;

(a) **Captural systems**, In this system no stocking of the rice fields with fish takes place. All fish captured at harvest originates from natural influx. This captural system almost completely disappeared in the CPP-area due to the irrigation with shallow or deep tube wells.

(b) **Culture systems**. In this system the rice fields are stocked with fish obtained from natural stocks or from hatcheries. Within this system it is necessary to differentiate between simultaneous production (i.e. fish and rice produced together in one rice field and alternate production, where fish and rice are produced separately.

9.3 Integrated rice-fish culture through simultaneous production has a number of advantages. the presence of fish increases rice production with approximately 10 %, through the control of weeds, insects and mollusca. Disadvantages are the higher water requirements and the limit to use High Yielding Varieties, insecticides and herbicides which are needed for the intensification of rice culture. The practical reality probably will be that integrated farming of rice-fish can only be introduced in those places where HYV cannot be introduced.

9.4 Certain modifications must be made to rice fields when rice and fish are produced simultaneously. First the heights of the bunds must be raised to give adequate depth of 25 cm of water in the rice fields and a ditch with a depth of 50 cm, must be made in order to provide shelter for the fish during periods of temperature extremes and temporarily shortages of water. In general the area occupied by the ditch is in the order of 10% of the total area and the soil obtained through the creation of the ditches is used to increase the bund height.

9.5 The modified rice fields can be stocked at a density of 2 fingerlings/m^2 of ditch area, 5-7 days after transplanting with Common carp, Tilapia or Labeo, species adapting easily to the harsh conditions of the rice fields. Average survival rates of fish is 60%, fed with agriculture by products and can be harvested after 120-150 days (depending on the rice variety) at an average weight of 120 g. A preliminary crop budget for this system is given below in Table 24.

TABLE 24 : A preliminary crop budget for the integrated farming of rice-fish.

		Crop budget for:		FISH IN PADDY FIELDS			
		TK/ha					
				FINANCIAL		ECONOMIC	
	ITEM	UNIT	NO. OF UNITS	UNIT VALUE	TOTAL	UNIT VALUE	TOTAL
1	PRODUCTION						
	Production GPV	kg	150	60,00	9000	49,20	7380
2	INPUT COSTS						
	Fingerlings	unit	2000	0,60	1200		0
	Feed (rice bran)	kg	700		0		0
	Materials	L/S	2	300,00	600		0
	Other inputs				0		0
	Total input costs				1800		0
3	LABOUR						
	Maintenance ditch	md	25	30,00	750	30,00	750
	Others	md	25	30,00	750	30,00	750
	Total labour	md	50		1500		1500
4	TOTAL COSTS				3300		1500
5	GROSS MARGIN				5700		5880

Source: This study

B Culture based fisheries

9.6 The Stocking of floodplain with carp fingerlings has been introduced recently in Bangladesh. In 1991, the first beels were stocked with fingerlings of different carp spp. The idea behind culture based fisheries is to obtain a surplus production of natural water bodies by stocking them with fast growing species, not present or not present anymore. The stocked fish will grow under natural conditions in the floodplain and are caught by the fishermen when the flood recedes to the river. In Bangladesh, at present, Catla, Ruhi, Mrigal, Silver carp, Common carp and Grass carps are used. The main problem encounter during the first year of this stocking program, was the availability of stocking material. The beels were stocked with rather large fish (average size 15-50 g).
From a technical point of view, culture based fisheries could be a tool in order to restore some of the lost natural carp production systems. In order to gain more insight in the feasibility of such a system two spreadsheet models were developed in which the following parameters were used:

(a) Natural production of the floodplain equals 55 kg/ha/year and the species composition follows the pattern as observed in the Tangail district (88/89).

(b) The fish are stocked at a density of 500 fingerlings/ha at 10st of June and are harvested at the 10st of November.

(c) Fish are stocked at high weight (15 g, as present situation) or at low weight (1.5 g), survival rates are respectively 20 % and 10 %, and they are bought for respectively 10 tk/piece and 5 tk/piece.

(d) The stocked fish is distributed as follows: Catla 40 %, Ruhi 12.5 %, Mrigal 12.5%, Mirror carp 25 %, Grass carp 10 %, Common carp 0 %, Mystus spp 0%.

(e) Maximum specific growth rate (in % of their body weight/day) is 2.5 %/day for the high weight group and 3.5 %/day for the low weight group. Within the simulation the final weight at catch is calibrated with these growth rates.

(d) Wholesale price for the caught fish is estimated at:

Catla	50 tk/kg
Ruhi	50 tk/kg
Mrigal	50 tk/kg
Silver carp	35 tk/kg
Grass carp	35 tk/kg
Common carp	40 tk/kg
Mystus spp	50 tk/kg

(f) Production costs (nets, boat, etc) are estimated at 7000 Tk/fishermen/year.

9.7 Under the specified conditions culture based fisheries produces an incremental quantity of 56 kg/ha and 26 kg/ha for respectively 'high weight" and "low weight" stocking, giving the fishermen a net dayly income of 45 Tk/day and 59 Tk/day, provided that they have acces to 4 ha of water.

Figure 18: Net income of fishermen in relation to their fishing area

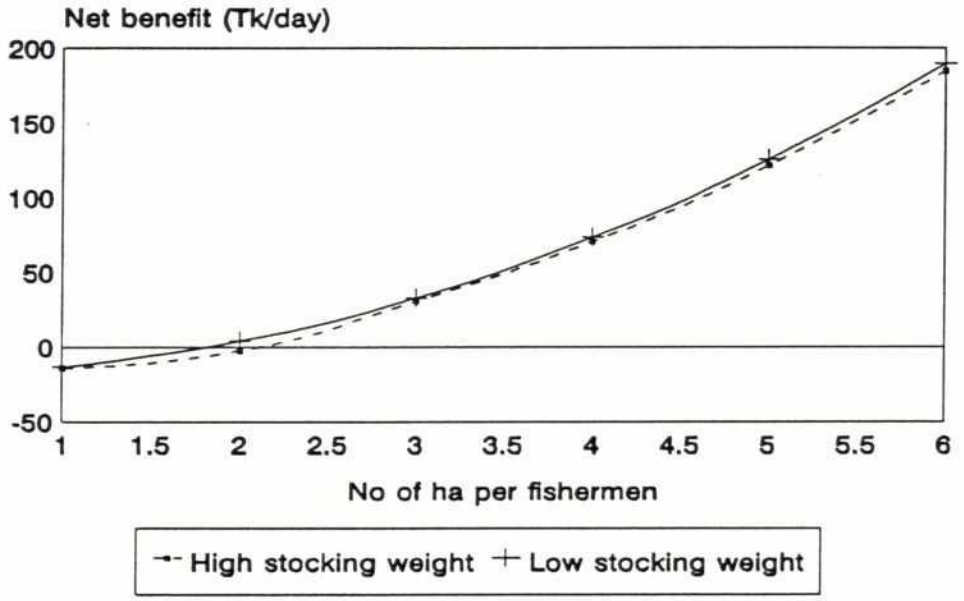
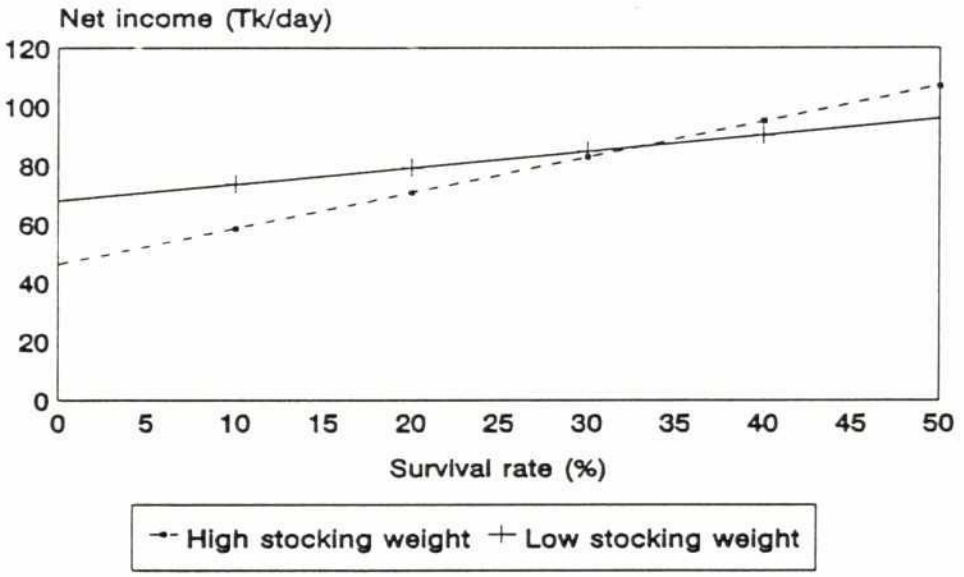


Figure 19: Net income fishermen in relation to survival rate of stocked fish



Each fishermen is operating in 4 ha.

9.8 A preliminary financial analysis of the net income of the fishermen, indicated that the main factors influencing the profitability are: the area available for the fishermen and the survival rate of the stocked material. The relation between the net income of the fishermen,

the area available for fishing and the survival rate of the stocked material is presented in Figures 18 and 19.
The stocking of the floodplain becomes only acceptable if the fishermen have access to a minimum area of 4 ha. Stocking with large or small fingerlings is in this respect not to important due to the fact that the major part of the catch is obtained from the "natural" population and the fact that different survival rates are incorporated in the analysis.
Once a fishing area of 4 ha is guaranteed, survival rate becomes important. Using small fingerlings is more profitable at low survival rates, and is less influenced by the survival rate, because the investments in fingerlings are lower. The use of large fingerlings can only be justified once a survival rate of more as 30% is obtained.

9.9 The introduction of integrated farming of rice/fish and culture based fisheries is technical feasible and can increase the total fisheries production. These option are however capital dependent, investment have to be made by private persons. This means that the part of the population which are deprived of their easy access to fish by changes in water management are not reached. With the introduction of culture based fisheries a socio-economic shift will take place. At present fishing in the floodplain is more or less free for everybody. Once fish are stocked by private persons or governmental organizations, access to fishing will be limited to the richer people due to protection of investments and licensing. The poorer people will profit only from mitigation if they are directed to the protection of natural resources. Such a shift is observed at present within the CPP-area at Jugini Beel, which has been stocked, by professional fishermen, with fry of the major carps in June/July 1992.

C Fish friendly regulators

9.10 One of the major concerns with the design ,construction and management of regulators must be the impact on natural fish resources. They should be constructed and operated in such a way that adult carp can migrate upstream at the beginning of May (not the case in the CPP area) and that hatchlings can enter the floodplain in June/July.

9.11 The migration of carp fry and fingerlings is more or less passively, at a certain moment thousands of young of the year are drifting downstream. This phenomenom occurs within a peak periods during the month May-July (see Figure 17). At a certain moment the concentration of hatchlings/fry per cubic meter of river water is extremely high. This is the moment in which the inlets should be open in order to have a maximum fisheries output.
From a fisheries point of view there is some flexibility, it is a question of weeks and flood water should enter in the peak period of june/july.

9.12 From a fisheries point of view the concept of gated openings is recommended, as long as the regulators/sluices are build in such a way that (passive) fish migration will not be hampered. The structures should be completely open from the bottom to the top layer of the water. This to facilitate all fish to enter. Migration of fish is related to the water layer they are in, carps, eggs end fingerlings are in the top layers. For example the regulators build at the western side of the CPP area next to the Delaswari and Elanjani river are a typical example of "fish destroying" structures. The ducts are passing the roads at approximately three meters below top water level. This means that the young fish should dive in order to pass, and this is not the case, most of the small fish will die, if they can pass at all, due to the damage done by touching the rough upper part of the structures and by the pressures differences obtained when they finally pass.

9.13 The operation of gated structures will probably be influenced by the more economic powerful people in the project area. These forces are not found among the landless, marginal farmers and fishermen and it can be expected that the operation will be agricultural dominated. Throttled regulators have the advantage that they operate as designed to do once they are placed. Within the design of throttled regulators special attention should be given in order to avoid whirling current before and after the regulator, known to trap and damage young fish.

9.14 Water velocity is not considered as a major factor to be considered for the CPP Area, as it is believed that no upstream migration takes place from the area into the river at the beginning of the pre-monsoon. But it should be realized that most hatchlings are found along the shore line of the river were current are relatively low (0.5-1.5 m/sec) and is probably optimal for migration and feeding behaviour.

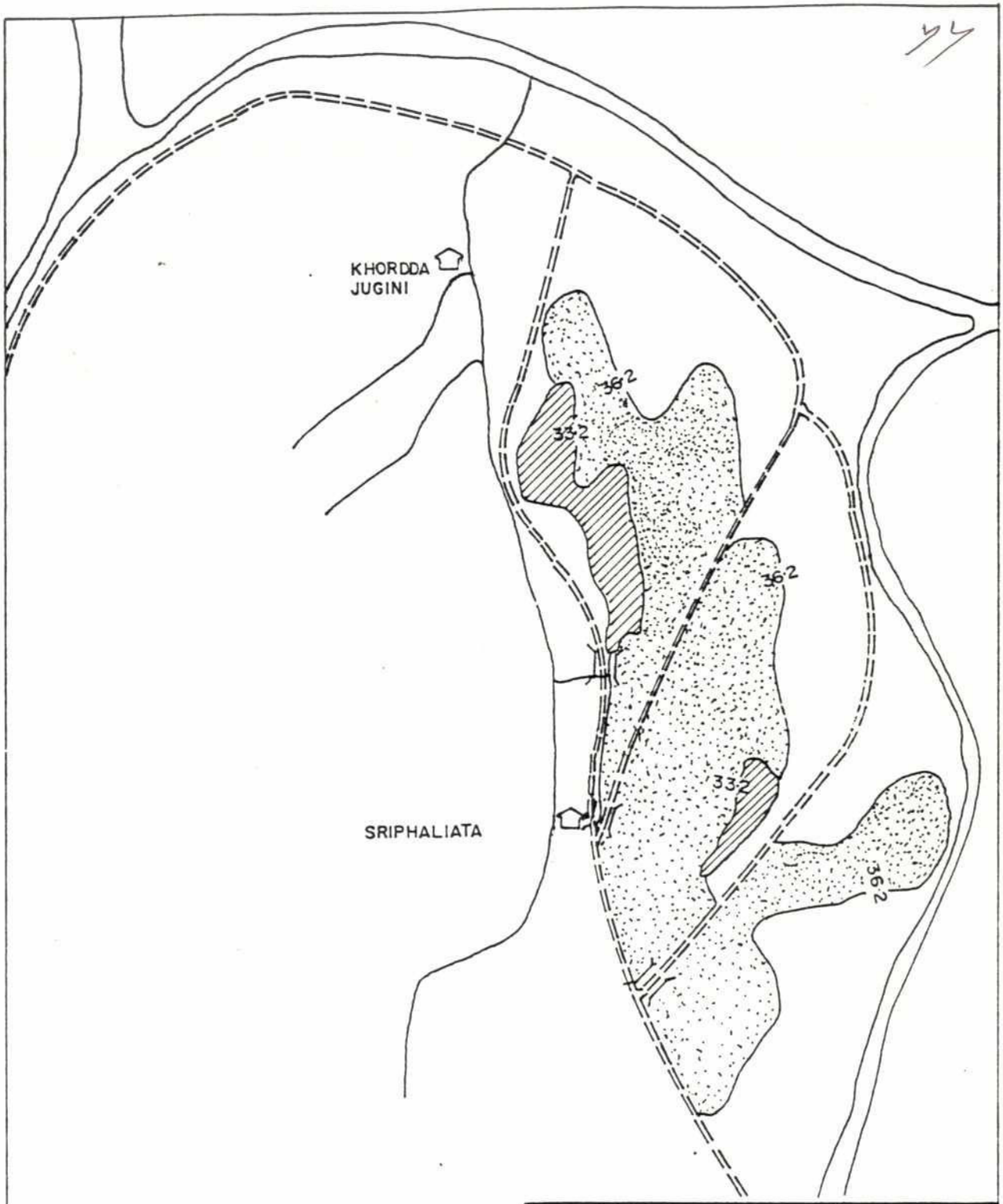
9.15 A major concern in the design of regulators are pressure differences. Fish can not withstand abrupt and high differences in pressure, it causes eruption of the swim bladder.

D **The Beel concept**

9.16 The early water rise of the beel, due to rainwater congestion is probably the triggering factor for reproduction of beel fish, followed by a nursing period in the shallow inundated low lands. Drainage of this rain water will probably result in delayed spawning of the "beel" fish. Within this situation the "beel" fish will reproduce at the moment the water raises because of the incoming river flood water. This incoming flood water carries also thousands of carp larvae into the beel and from a ecological point of view a hazardous situation is created. Two groups with their own reproductive strategy, living in separate ecological niches are mixed, resulting in a competition for food in their early life and it can be expected that the later born "beel" fish will lose this struggle.

9.17 A concept for multipurpose water management of beels has been developed by FAP 13. The idea behind the concept is the removal of the potential area of conflict, namely between low land farmers and fishermen through the construction of submersible embankments and peripheral drains. Unfortunately only "carp" fisheries is considered within this concept and "beel" fish will be reduced due to the above (9.15) mentioned reasons. The existing potential within this concept to shift gradually from captured fisheries to culture based fisheries will restrict the open access to fisheries for the poorest (see 9.8). For this reason the introduction of this concept within the CPP-area is not recommended.

9.18 It is realised that also within the CPP project area a conflict of interest exists between low land farmers and fishermen; the farmers want to drain the early rainwater and river flood water, in order to protect their crops and the fishermen need this water for fishing. The "people"within the CPP-project area propose; excavation of the khal to improve drainage and fish migration and deepening of the beels to increase fisheries production. However this concept is agriculture orientated. As mentioned in earlier in 8.6 excavation of the khals will not improve carp fisheries as long as the situation in the main rivers is not improved. It is a traditional custom in Bangladesh to deepen some parts of the beel in order to avoid siltation, to create drinking an washing places for cattle and to improve fisheries. However this "improvement" in fisheries is caused by an increased local catch. Deepening of the beels does not increase directly fisheries production as this is more related to surface area. Siltation of the beels is a problem in Bangladesh and the total surface area of the beels is gradually decreasing. Within this respect, deepening of the beels can stabilise or improve the fisheries production.



LEGEND :-

- River & Khal
- Beel
- Road
- Rain Water Congestion
- Contour line
- Village

MINISTRY OF IRRIGATION, WATER DEVELOPMENT AND FLOOD CONTROL
BANGLADESH WATER DEVELOPMENT BOARD
FLOOD PLAN COORDINATION ORGANIZATION

COMPARTMENTALIZATION PILOT PROJECT
FAP 20

JUGINI BEEL AREA

CONSULTANTS : Ebasconsult, Lahmeyer Int, Beta Ltd, MCL.

Drawn by :	Checked by :	Fig. no. 20
Date:	Date:	

Figure 20: A map of the Jugini Beel Area

9.19 Beel fish production should be taken into consideration if it is decided to drain of early rainwater in the CPP project area in order to improve the situation for the low land farmers. It is proposed to create in each beel a "Beel fish reserve", an area which cannot be used for agriculture purposes in which the water level still fluctuates due to the early rainfall. From an engineering point of view this is easy to realize through the construction of overspill structures in the drainage canals. The top level of the overspill should be minimal 1 meter above the minimum dry season water level of the beel. This system provides a water rise needed for reproduction and inundation of a part of the low lying areas needed for the nursing of beel fish. This system blocks, in theory, the outward migration of mature carps. This phenomenum is however at present not occurring in the CPP project area, contact between the beels and the river is made by the incoming flood water. It should be realised that the proposed system is a compromise, fisheries will still be negatively affected but it is not realistic to believe that fisheries can withstand the existing agriculture pressure.

9.20 Within the CPP project area Jugini beel is considered to be the best place to introduce and test the proposed beel concept and well for the following reasons:

(a) The whole beel is surrounded by dikes and roads and there is only one connection with the Lohajang river through Jugini Khal (see Figure 20). Execution of the concept is rather easy and construction costs will be limited.

(b) Fisheries output of Jugini beel is followed by the Special Fisheries Study, which means that a base line is available to monitor the effect of the proposed concept.

(c) A part of Jugini beel is leased by the professional fishermen living around the beel and good cooperation in guarding and monitoring of their "beel fish reserve" can be expected.

10 THE SPECIAL FISHERIES STUDY

A The programme

10.1 Studies of the Irrigation Fisheries Development Project (1978-1982) and FAP 12 have indicated that the evaluation of impact of FCD/I projects on fisheries is hampered by the fact that baseline data of the pre-project situation is scarce. A special study in the Tangail compartment will start under FAP 20 in May 1992 and will continue for one year. The study will cover:

- Frame survey; determination of the number of fishermen, gears a fishing intensity for the different classes and habitats.
- Catch assessment; determination of the catch per unit effort and its seasonal variation of the main gears. The samples will be analysed on weight, main species composition and the length frequency distribution.
- Reproductive strategies; reproduction and migration patterns of the main river and beel fish will be followed by sampling the northern water-inlets, three beels and the Lohajang river at regular intervals. The samples will be analysed on species composition, year classes, length frequency distribution and on the Gonado Somatic Index.

Details of this study are given in Appendix 1

10.2 The special fisheries study will be executed in close cooperation with FAP 17 and FAP 16 and, where possible, the different teams will be joined. The methodology is as such, that full exchange and use of data is possible. The study should result in figures on the total catch, total consumption (covered by FAP 16), yield/recruit and a better understanding of reproduction and migration of fish.

B Tools needed for the development of a fisheries management strategy

10.3 The catch per unit effort (CPUE), or the quantity of fish caught by a fishing unit in a certain time period, is one of the most important tools to monitor fisheries exploitation. It can be calculated on a roughly for all the inland fishermen of Bangladesh, as is done in Figure 21.

Such a figure gives general information on the fisheries status as a whole: The total inland catch declined and the CPUE declined relatively more, because every year, more fishermen are hunting the same stocks.

10.4 The diversification of fishing methods in Bangladesh is rather big and therefore within the catch assessment figure this should be included. Data on CPUE of the different gear types in the different fishing habitats will provide the insight needed for the development of fisheries management scenario's. In 1983 DOF started with a survey program, following all aspects of inland fisheries. One of the aims was to provide CPUE data for the different gears and habitats. However the data are not yet published in such a form. For the Tangail district, "raw" data on river fisheries, for the season 89/90, were obtained from DOF/BFRSS and the CPUE of gillnets was calculate over the season (Figure 22).

Figure 21: CPUE of inland fisheries in Bangladesh

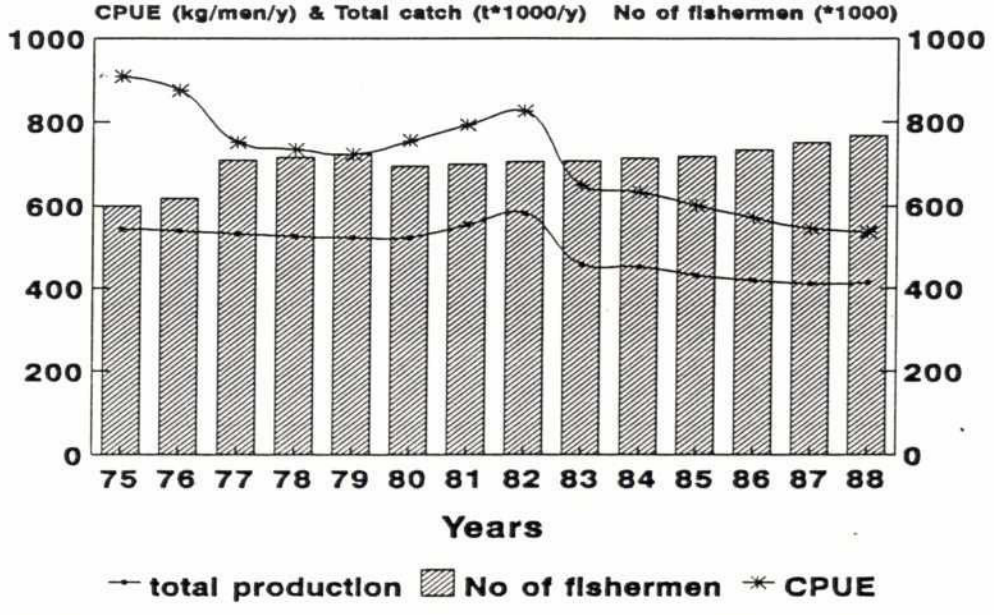
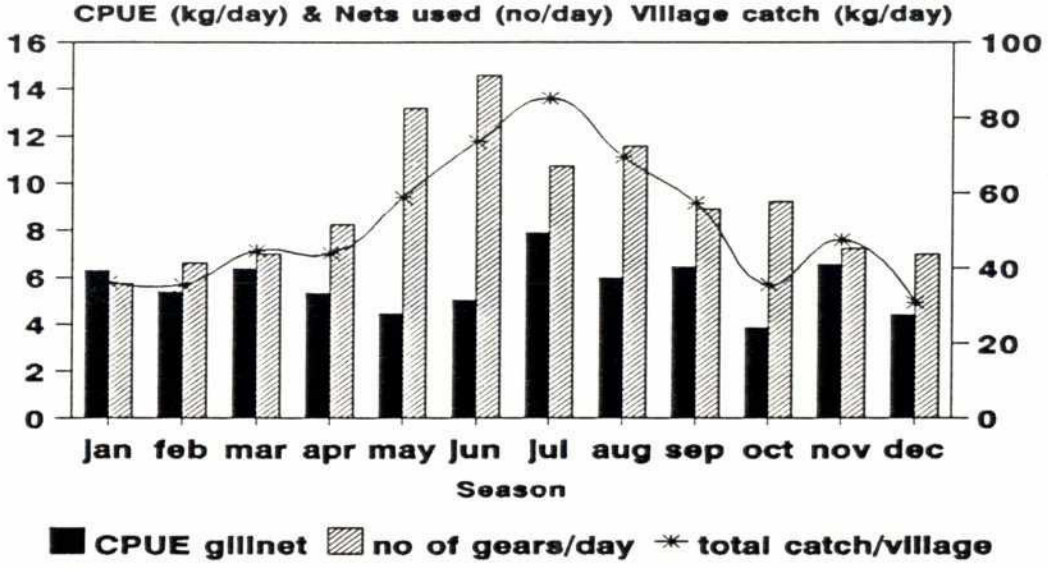


Figure 22: Gillnet fisheries in Tangail
Jamuna & Daleshwari river (89/90)



Source: unpublished data DOF

All "raw" data available for the CPP area should be presented in such a way, unfortunately most of the "raw" material is not yet computerized or is difficult to trace and analyze. Results from the Special Fisheries Study will be presented this way.

10.5 Preliminary results of the catch assessment of the Special Fisheries Study are presented in Table 25.

TABLE 25: Some preliminary data of CPUE of different fishing methods in the CPP area.

	DRY SEASON			RAINY SEASON		
	CPUE g/type/day	N	S.E.M	CPUE g/type/day	N	S.E.M
Seine net	17800	16	120	50900	13	340
Cast net	1820	19	170	7000	2	2200
Scoop net	224	5	100			
Hand picking	162	4	81			
Baskets	98	12	28			

Source: This study

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APPENDIX I

BANGLADESH FLOOD ACTION PLAN

COMPARTMENTALIZATION PILOT PROJECT

FAP 20

SPECIAL FISHERIES STUDY

PROPOSAL

TANGAIL, MARCH 1992

i SUMMARY

S.1 The objectives of the proposed Special Fisheries Study is to collect substantial baseline data on the existing fisheries in the CPP area. The study will take place from april 1992 to April 1992 and will cover the following subjects:

- Frame survey on the number of fishermen, gears and fishing intensity.
- Determination of the catch per unit effort for the different gears or fishing techniques. length frequency distribution and yield per recruits
- Fish migration routes.
- Reproductive behaviour of River and Beel fish.

S.2 The results of this study will be used in the impact assessment of water management scenario's on fisheries and the formulation and design of mitigation measurements and structures.

S.3 The study will be executed in cooperation with FAP 16 (environment) and FAP 17 (fisheries). FAP 20 and FAP 16 will cover the beels, rivers, floodplain, fish consumption, reproduction and migration routes within the CPP area. FAP 17 will cover the major rivers and floodplain surrounding the CPP area. The chosen methodology makes a complete exchange of results possible.

S.4 The costs for this study are estimated at 7,01.500 Tk, salaries excluded.

1 INTRODUCTION

1.1 Within the national context the annual fish production of approximately 840.000 T plays an important role in the economy of Bangladesh. The sector accounts for 3% of GDP, 11 % of export earnings and 70% of the animal protein intake of its population. Inland fisheries and aquaculture are the major contributors of fish, covering respectively 50 % and 22 % of the total production (DOF/BFRSS, 1990[1]).

1.2 The seasonal variations of flow in the rivers and the congestion of water in the depressions of the floodplain are the main factors influencing the behavior of fish communities in Bangladesh.

1.3 Pre-monsoon: The water level in the rivers and depression areas (beels) of the floodplain raises due to the early rains. The rising water invades the nearby plains and organic and inorganic matter lying on the plains enters solution, providing the nutrients needed for biological production.

1.4 The monsoon: The continuous rainfall and the influx of water in the upper catchment areas saturates the main channels, the water continues to rise and eventually spills over through a system of channels inundating the floodplain and the low lying depression areas completely. Debris of animal and vegetal origin starts rotting and the availability of nutrients in the water increases rapidly.

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[1] Directorate of Fisheries, Statistical Yearbooks

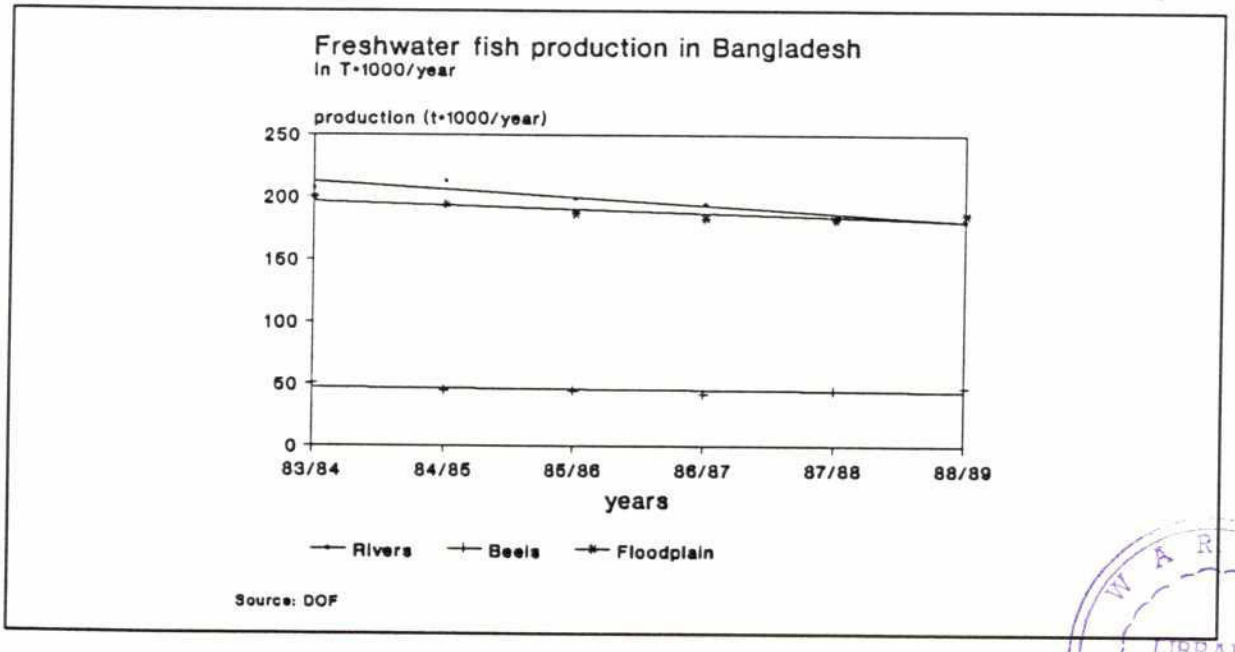
1.5 Receding waters: At the onset of the dry season the water in the floodplain start to flow back in the main channels. Gradually the floodplain dries up and the low lying "beels" and "pagars" are cut off again from the main river systems.

1.6 The dry season: Within the dry season the evaporation and drainage of water exceeds the influx of water. As a result the water level in the rivers and permanent water bodies of the floodplain decreases.

1.7 A preliminary survey in the Tangail Pilot Project area, executed in the dry season of March 1991 highlighted that
the fish species can be divided in two groups when their reproductive behaviour is taken into account.

1.8 **River fish**, such as the major carps (Catla, Rui, Mrigal), spawn upstream in the Jamuna river at the beginning of the rainy season. The eggs, larvae, fingerlings and some adults of these species are flowing downstream with the water current into the Daleswari and Pungli river, finally entering the floodplains of the project area from the North side, through the Lohajan River, Sadullahpur Khal and Jugini Khal at the end of June. The inundated floodplain provides the carps all the nutrients needed for growth. The carps are migrating passively back to the main river as soon as the water recedes from the floodplain.

1.9 **Beel fish**, such as snakeheads (Taki, Shol), catfish (Magur), climbing perch (Koi), gouramies (Kailsha), barb (Puti) etc, can survive the harsh environmental condition of the floodplain during the dry season. This group probably reproduces in the pre-monsoon as soon as the water level in the beel rises. First nursing takes place in the inundated areas adjacent to the beels; later on they disperse all over the floodplain, once the river flood water enters. With the receding waters this group migrate back or get trapped in the low lying beels and pagards (ditches and borrow pits) .



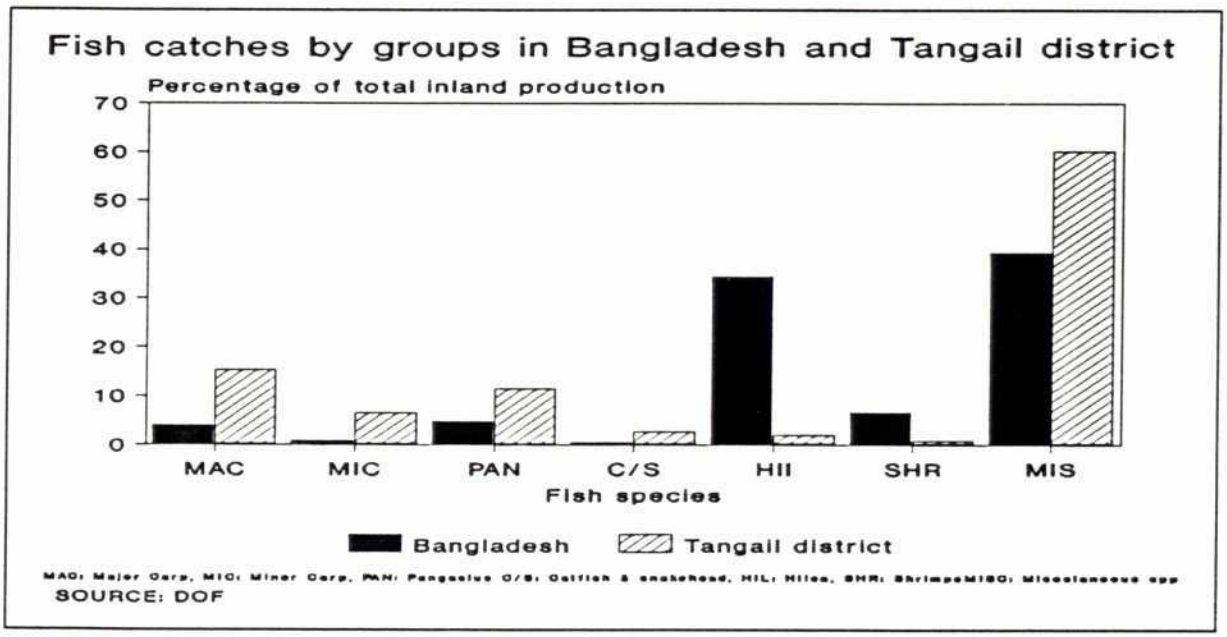
1.10 The decline in inland fisheries catches during the last decade (see figure) is a field of major concern.

1.11 The objective of the fisheries component of the CPP pilot project is to increase the availability of fish by securing fisheries production and by improving aquaculture, which is only possible with a thorough understanding of the systems

1.12 Studies of the Irrigation Fisheries Development Project (1978-1982) and FAP 12 have indicated that the evaluation of impact of FCD/I projects on fisheries is hampered by the fact that baseline data on the pre-project situation are scarce. It is realised that it is difficult to obtain baseline data through field surveys of short duration, and a special study of one year, to be started in May 1992,is proposed.

2. THE SPECIAL FISHERIES STUDY

2.1 The study will concentrate on the major carps as well as on the so called "small" or

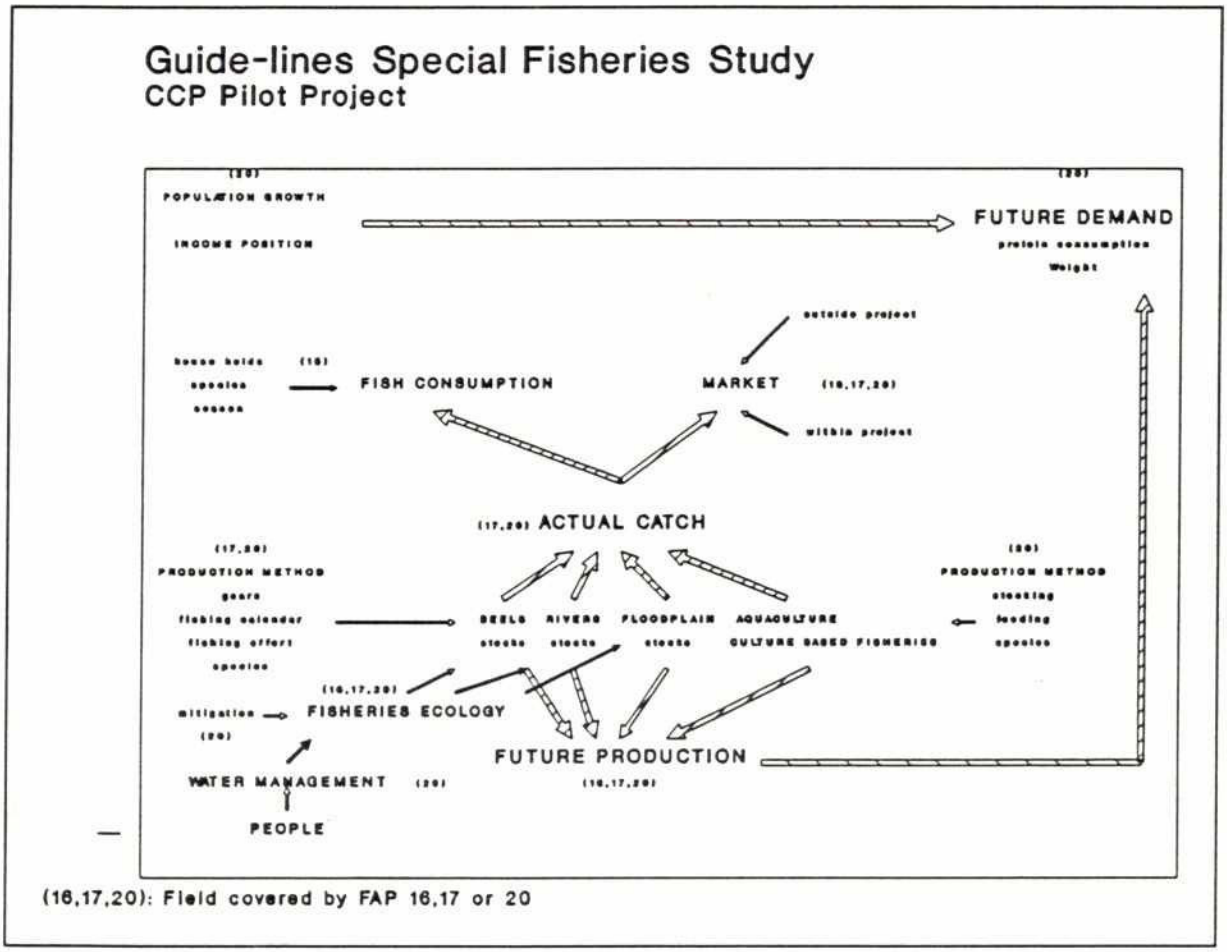


"miscellaneous" fish species.
The results of a preliminary survey, executed by FAP 16, indicated that the last group contributes largely to the fish consumption in the rural areas of the CPP project.
This group also represents 40% and 60% of the total inland fisheries catch of respectively Bangladesh and the Tangail district (see figure).

2.2 Preliminary results of the multi-disciplinary sub-compartmental survey indicated that a major concern of the people is the congestion of water during the pre- and post-monsoon due to improper drainage facilities. Complete drainage of the early rains could result in delayed spawning of the "beel" fish. As a consequence, there would be competition for between the carp fingerlings and the hatchlings of the "beel" fish, once the river flood enters

the beels. Such a phenomenon could have drastic consequences for the survival of "beel" fish and the protein supply during the dry season.

2.3 The study should result in figures on; total catch, total consumption (covered by FAP 16), yield/recruit, growth and a better understanding of reproduction and migration of fish in the different habitats. The results of this study will be used in the impact assessment of water management scenario's on fisheries and the formulation and design of mitigation measurements and structures.



A general guide line of the work and the linkages with FAP 16 and FAP 17 , and the methodology to be used, is presented below

2.4 Four different fishing habitats are of importance when hydrological and biological components are considered.
For each fishing habitat the following representative sites are selected.
- Rivers: Lohajang, Pungli, Dhaleswari.
- Beels: Jugini beel, Garinda beel and Boro Beel.
- Floodplain: Garinda floodplain Danya floodplain.
- Canals: Jugini Khal, Sadhullapur Khal, Fatepur Khal.

2.5 **Frame survey**: The number of fishermen, used gears and fishing intensity for the different classes and fishing habitats will be determined by bi-weekly standardized counting.

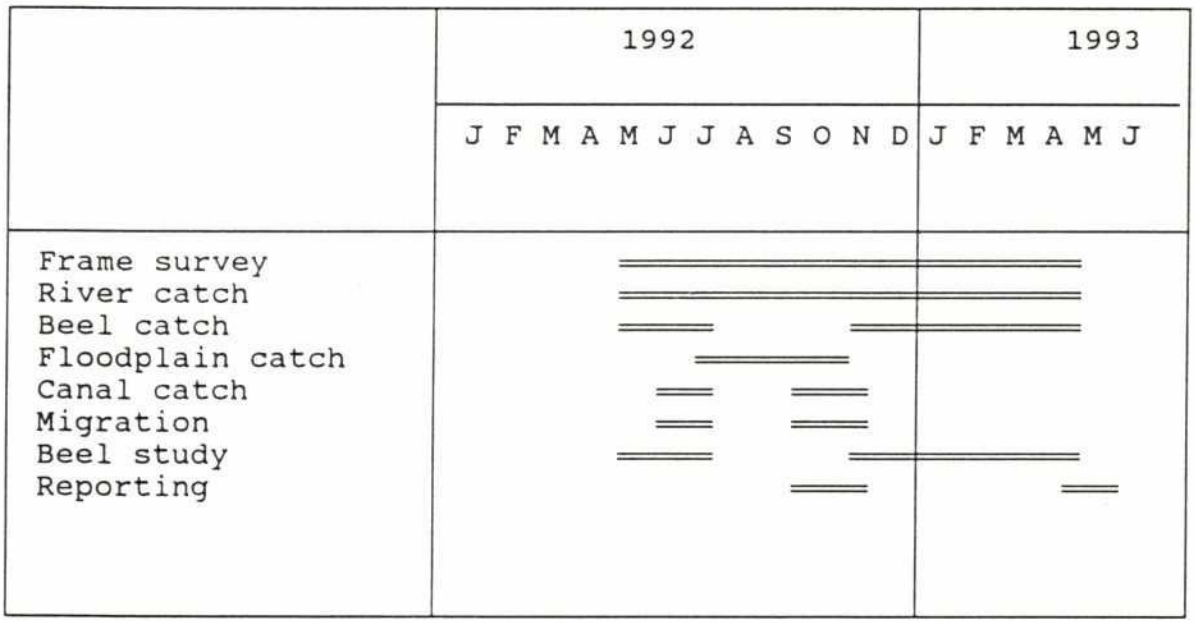
2.6 **Catch assessment**: The catch per unit effort and its seasonal variation of the main gears will be determined.
Catch samples will be analysed on; weight, main species composition and length frequency distribution.

2.7 **Reproductive strategies**: reproduction and migration patterns of fish will be studied by sampling; Jugini Khal, saddulhapur Khal and the Lohajang river at weekly intervals during the early flood period
The samples will be analysed on; larval fish, species composition, year classes, length frequency distribution and for the main species the Gonado Somatic Index (GSI) will be determined.

2.8 **Beel study**: The influence of meteorological (rainfall) and hydrological (water level) factors on the reproduction (GSI) of snakehead (taki), catfish (magur), barbs (puti), climbing perch (koi), gouramy (kailsha) and spiny eel (baim) will be studied.

3. WORK SCHEDULE

3.1 The planned work schedule is presented below.



4. STAFFING SCHEDULE AND REQUIREMENTS

4.1 Two field teams will be formed in order to gather data in the field. Each team consists of two junior biologists and occasional a professional fisherman is attached to it. The two teams are supervised by the senior fisheries biologists of FAP 20 and FAP 16.

4.2 **Junior Fisheries Biologist**: Four junior biologist (M.Sc) are planned (24 m/m)[2]. They are responsible for field data collection; gear counting, fish weighing, length measurements, species identification, determination of GSI in the laboratory.

4.3 **Senior Fisheries Biologist**[3]: A senior biologist (M.Sc), with several years of field experience is planned for 6 m/m. He/She is responsible for the supervision/guidance of the field teams, analysis and organisation of the raw data, monthly report writing and the liaison with FAP 17 and FAP 16.

4.4 **Fisheries Expatriate Consultant**: A senior biologist, with several years of field experience is planned for 3 m/m. Responsible for the overall guidance, start up of the field work and final reporting of the study.

4.5 **Occasional labour**: 6 m/m of occasional labour, fishermen are planned for special sampling, fish identification, etc.

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[2] FAP 16 will take care of 2 junior biologists

[3] In present budget

5. COSTS ESTIMATE

5.1 The purchasing and operational costs (salaries excluded) are estimated at 7,01.500 Tk, specifications are given below.

COSTS in TK	(000)			
EQUIPMENT				
	UNIT	NO OF UNITS	UNIT PRICE	TOTAL
Moped	unit	4,0	40,0	160,0
Boat	unit	1,0	40,0	40,0
Engine	unit	1,0	60,0	60,0
Nets	kg	30,0	0,2	6,0
Dissection	unit	3,0	3,0	9,0
Balance	unit	8,0	2,0	16,0
fridgerator	unit	1,0	30,0	30,0
Computer AT	unit	1,0	60,0	60,0
Containers	lumpsum			30,0
Furniture	lumpsum			10,0
TOTAL				421,0
OPERATION				
	UNIT	NO OF UNITS	UNIT PRICE	TOTAL
Laboratory	unit	1,0	100,0	100,0
Petrol	ltr	2700,0	0,0	40,5
Formalin	ltr	100,0	0,2	20,0
Furniture	lumpsum			20,0
Fish samples	kg	2000,0	0,0	60,0
Miscellaneous	lumpsum			30,0
labour	days	100,0	100,0	20,0
TOTAL				290,5

APPENDIX 2: FISHERIES FORMS OF THE SPECIAL FISHERIES STUDY

DATE: MAUZA NAME:

NAME FISHING PLACE:

HABITAT: BEEL---RIVER---FLOODPLAIN---OTHERS

OTHERS SPECIFY:

SITE NUMBER:

FISHERMEN: PROF----OCAS----SUBSIS

NAME OF LIVING VILLAGE:

PROFESSIONAL FISHERMEN

SHARING CATCH: YES----NO

IF SHARING YES, THEN PERCENTAGE OF SHARING: %

OPERATING: GROUP-----ALONE

NO OF FISHERMEN IN GROUP: 1--2--3--4--5--6--7--8--9--more

INCOME YESTERDAY: TAKA/PERSON

INCOME BEFORE YESTERDAY: TAKA/PERSON

OCCASIONAL FISHERMEN

SPECIFY OTHER ACTIVITIES:

FISHING INCOME YESTERDAY: TAKA/DAY

FISHING INCOME BEFORE YESTERDAY: TAKA/DAY

OBSERVATIONS

SFS, FORM NO 2A, CATCH ASSESSMENT

GEAR SAMPLING

GEAR TYPE	YES is X	NO USED	MESH SIZE IN MM	OWNED-HIRED
BERD JAL SEINE NET				
TAKI JAL CAST NET				
KERRENT JAL GILL NET				
JALI JAL SCOOP NET				
DORMA JAL LIFT NET				
HOSA JAL BASKETS				
DARKI TRAPS				

WEIGHT SAMPLES

SFS, FORM NO 2A, CATCH ASSESSMENT

TOTAL WEIGHT CATCH: KG
TOTAL WEIGHT SUB-SAMPLE: KG

BEEL FISH

GROUP	SNH	CTF	PUT	KOI	GUT	BAI	SHR		
WEIGHT									
NUMBER									

RIVERINE FISH

SPECIES									
WEIGHT									
NUMBER									

SFS, FORM NO 2A, CATCH ASSESSMENT

DATE: MAUZA NAME:

NAME FISHING PLACE:

HABITAT: BEEL---RIVER---FLOODPLAIN---CANAL---OTHERS

OTHERS SPECIFY:
SITE NUMBER:

FISHING:------- PROF-------OCCAS-------SUBSIST

GEAR TYPE: MESH SIZE: MM

GROUP BEEL FISH: SNH---CTF---PUT---KOI---BAI---GUT---CRP---OTH

SPECIES NAME/GROUP NAME RIVER FISH:

SPECIES NAME: BENGALI NAME:

TOTAL WEIGHT SAMPLE/CATCH: KG

LENGHT MEASUREMENTS OF A SINGLE SPECIE IN CM

SFS, FORM NO 2C, FRAME SURVEY

FRAME SURVEY FORMAT

DATE:

HABITAT: BEEL---RIVER---FLOODPLAIN---OTHERS

OTHERS SPECIFY:

SITE NUMBER:

NUMBER OBSERVED	MORNING	AFTERNOON
CAST NETS		
LIFTNETS		
SCOOP NETS		
GILL NETS		
SEINE NETS		
KATA FISHING		
LINING		
HAND PICKING		
DEWATERING		
OTHER		

APPENDIX 3: DETAILS OF THE IMPACT ASSESSMENT

SCENARIO NUMBER 1 EXISTING SITUATION

FLOODPLAIN & KHALS 1.535 KG/HA/10 DAYS FLOODPLAIN PRODUCTION 55.3 KG/HA/YEAR
FLOODPLAIN PRODUCT 183 TONS
BEEL PRODUCTION 127 TONS

MONTH	DAY	AREA FLOODPLAIN EXIST BEEL HA	AREA SCENARIO EXIST BEEL HA	FLOODPLAIN PRODUCT TONS/YEAR	BEEL PRODUCT TONS/YEAR	REL BEEL PRODUCT (KG/HA/10 Days)
JAN	10	0	400	0.0	4.8	12.0
JAN	20	0	400	0.0	16.8	42.0
JAN	30	0	300	0.0	16.8	56.1
FEB	10	0	300	0.0	16.8	56.1
FEB	20	0	300	0.0	14.6	48.8
FEB	30	0	200	0.0	14.6	73.2
MAR	10	0	200	0.0	14.6	73.2
MAR	20	0	180	0.0	2.8	15.7
MAR	30	0	180	0.0	2.8	15.7
APR	10	0	170	0.0	2.8	16.6
APR	20	0	170	0.0	0.0	0.0
APR	30	0	150	0.0	0.0	0.0
MAY	10	0	150	0.0	0.0	0.0
MAY	20	0	1084	0.0	1.6	1.5
MAY	30	0	1611	0.0	2.4	1.5
JUN	10	0	1666	0.0	2.5	1.5
JUN	20	5889	0	9.0	0.0	0.0
JUN	30	8099	0	12.4	0.0	0.0
JUL	10	8656	0	13.3	0.0	0.0
JUL	20	10361	0	15.9	0.0	0.0
JUL	30	10203	0	15.7	0.0	0.0
AUG	10	8663	0	13.3	0.0	0.0
AUG	20	9266	0	14.2	0.0	0.0
AUG	30	9326	0	14.3	0.0	0.0
SEP	10	9198	0	14.1	0.0	0.0
SEP	20	10008	0	15.4	0.0	0.0
SEP	30	9130	0	14.0	0.0	0.0
OCT	10	7899	0	12.1	0.0	0.0
OCT	20	5912	0	9.1	0.0	0.0
OCT	30	3979	0	6.1	0.0	0.0
NOV	10	2671	0	4.1	0.0	0.0
NOV	20	0	2000	0.0	1.2	0.6
NOV	30	0	1500	0.0	1.2	0.8
DEC	10	0	1000	0.0	1.2	1.2
DEC	20	0	500	0.0	4.8	9.6
DEC	30	0	400	0.0	4.8	12.0

SPECIES WIDE PRODUCTION FIGURES
SCENARIO 1 EXISTING SITUATION

SPECIES	PRODUCTION PRINCIPAL RIVERS (%)	PRODUCTION MINOR RIVERS (%)	PRODUCTION BEEL (%)	PRODUCTION FLOODPLAIN (%)	PRODUCTION PONDS (%)	PRODUCTION TOTAL HABITATS (%)
MAJOR CARP	2.1	6.3	8.4	2.2	16.4	4.7
MINOR CARP	2.1	0.5	8.6	0.0	33.2	7.6
CATFISH	1.1	0.5	12.5	9.6	9.3	9.2
LIVE FISH	0.0	4.5	6.3	2.9	11.6	5.1
HILSA	23.4	0.0	0.0	0.0	0.0	0.3
MACROBRACHIUM	0.0	0.0	0.0	0.0	0.0	0.0
SMALL SHRIMP	10.6	2.0	3.8	0.0	0.0	0.6
MISCELANUOUS	60.6	86.3	60.4	85.3	29.4	72.5
TOTAL	100	100	100	100	100	100

SPECIES	PRODUCTION PRINCIPAL RIVERS (TON/YEAR)	PRODUCTION MINOR RIVERS (TON/YEAR)	PRODUCTION BEEL (TON/YEAR)	PRODUCTION FLOODPLAIN (TON/YEAR)	PRODUCTION PONDS (TON/YEAR)	PRODUCTION PITS & DER PONDS (TON/YEAR)	PRODUCTION TOTAL HABITATS (TON/YEAR)
MAJOR CARP	0.6	0.9	10.7	4.0	6.6	0.6	23.4
MINOR CARP	0.6	0.1	10.9	0.0	13.3	0.0	24.9
CATFISH	0.3	0.1	15.9	17.6	3.7	2.5	40.1
LIVE FISH	0.0	0.6	7.9	5.3	4.6	0.8	19.3
HILSA	7.0	0.0	0.0	0.0	0.0	0.0	7.0
MACROBRACHIUM	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SMALL SHRIMP	3.2	0.3	4.8	0.0	0.0	0.0	8.3
MISCELANUOUS	18.2	12.1	76.8	156.1	11.8	22.2	297.1
TOTAL	30	14	127	183	40	26	420

SPECIES	MARKET PRICE TK/KG	ECONOMIC VALUE US$ 1000	TK (lhk)
MAJOR CARP	60	36	14
MINOR CARP	50	32	12
CATFISH	90	93	36
LIVE FISH	100	49	19
HILSA	100	18	7
MACROBRACHIUM	120	0	0
SMALL SHRIMP	40	9	3
MISCELLANEOUS	40	305	119
TOTAL		541	211

SCENARIO NUMBER 2 DRAINAGE ONLY

FLOODPLAIN & KHALS 1.535 KG/HA/10 DAYS FLOODPLAIN PRODUCTION 55.3 KG/HA/YEAR
FLOODPLAIN PRODUCT 174 TONS
BEEL PRODUCTION 88 TONS

MONTH	DAY	AREA FLOODPLAIN BEEL HA	AREA SCENARIO BEEL HA	AREA EXIST HA	FLOODPLAIN PRODUCT TONS/YEAR	BEEL PRODUCT TONS/YEAR	REL BEEL PRODUCT (KG/HA/10 Days)
JAN	10	0	400	400	0.0	3.4	12.0
JAN	20	0	400	400	0.0	11.7	42.0
JAN	30	0	300	300	0.0	11.8	56.1
FEB	10	0	300	300	0.0	11.8	56.1
FEB	20	0	300	300	0.0	10.2	48.8
FEB	30	0	200	200	0.0	10.2	73.2
MAR	10	0	200	200	0.0	10.2	73.2
MAR	20	0	180	180	0.0	2.0	15.7
MAR	30	0	180	180	0.0	2.0	15.7
APR	10	0	170	170	0.0	2.0	16.6
APR	20	0	170	170	0.0	0.0	0.0
APR	30	0	150	150	0.0	0.0	0.0
MAY	10	0	150	150	0.0	0.0	0.0
MAY	20	0	1003	1084	0.0	1.5	1.5
MAY	30	0	1836	1611	0.0	2.8	1.5
JUN	10	0	1164	1666	0.0	1.8	1.5
JUN	20	5563	0	0	8.5	0.0	0.0
JUN	30	7706	0	0	11.8	0.0	0.0
JUL	10	8503	0	0	13.1	0.0	0.0
JUL	20	10386	0	0	15.9	0.0	0.0
JUL	30	10117	0	0	15.5	0.0	0.0
AUG	10	8549	0	0	13.1	0.0	0.0
AUG	20	9207	0	0	14.1	0.0	0.0
AUG	30	9268	0	0	14.2	0.0	0.0
SEP	10	8889	0	0	13.6	0.0	0.0
SEP	20	9453	0	0	14.5	0.0	0.0
SEP	30	8956	0	0	13.7	0.0	0.0
OCT	10	7617	0	0	11.7	0.0	0.0
OCT	20	5303	0	0	8.1	0.0	0.0
OCT	30	3017	0	0	4.6	0.0	0.0
NOV	10	737	0	0	1.1	0.0	0.0
NOV	20	0	577	2000	0.0	0.2	0.6
NOV	30	0	493	1500	0.0	0.3	0.8
DEC	10	0	450	1000	0.0	0.4	1.2
DEC	20	0	400	500	0.0	2.7	9.6
DEC	30	0	400	400	0.0	3.4	12.0

SPECIES WIDE PRODUCTION FIGURES
SCENARIO DRAINAGE ONLY

SPECIES	PRODUCTION PRINCIPAL RIVERS (%)	PRODUCTION MINOR RIVERS (%)	PRODUCTION BEEL (%)	PRODUCTION FLOODPLAIN (%)	PRODUCTION PONDS (%)	PRODUCTION TOTAL HABITATS (%)
MAJOR CARP	2.1	6.3	8.4	2.2	16.4	4.7
MINOR CARP	2.1	0.5	8.6	0.0	33.2	7.6
CATFISH	1.1	0.5	12.5	9.6	9.3	9.2
LIVE FISH	0.0	4.5	6.3	2.9	11.6	5.1
HILSA	23.4	0.0	0.0	0.0	0.0	0.3
MACROBRACHIUM	0.0	0.0	0.0	0.0	0.0	0.0
SMALL SHRIMP	10.6	2.0	3.8	0.0	0.0	0.6
MISCELANUOUS	60.6	86.3	60.4	85.3	29.4	72.5
TOTAL	100	100	100	100	100	100

SPECIES	PRODUCTION PRINCIPAL RIVERS (TON/YEAR)	PRODUCTION MINOR RIVERS (TON/YEAR)	PRODUCTION BEEL (TON/YEAR)	PRODUCTION FLOODPLAIN (TON/YEAR)	PRODUCTION PONDS (TON/YEAR)	PRODUCTION PITS & DER PONDS (TON/YEAR)	PRODUCTION TOTAL HABITATS (TON/YEAR)
MAJOR CARP	0.6	0.9	7.4	3.8	6.6	0.6	19.9
MINOR CARP	0.6	0.1	7.6	0.0	13.3	0.0	21.5
CATFISH	0.3	0.1	11.0	16.7	3.7	2.5	34.4
LIVE FISH	0.0	0.6	5.5	5.0	4.6	0.8	16.6
HILSA	7.0	0.0	0.0	0.0	0.0	0.0	7.0
MACROBRACHIUM	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SMALL SHRIMP	3.2	0.3	3.3	0.0	0.0	0.0	6.8
MISCELANUOUS	18.2	12.1	53.2	148.4	11.8	22.2	265.8
TOTAL	30	14	88	174	40	26	372

SPECIES	PRICE TK/KG	ECONOMIC VALUE US$ 1000	ECONOMIC VALUE TK (1hk)
MAJOR CARP	60	31	12
MINOR CARP	50	28	11
CATFISH	90	79	31
LIVE FISH	100	42	17
HILSA	100	18	7
MACROBRACHIUM	120	0	0
SMALL SHRIMP	40	7	3
MISCELANUOUS	40	273	106
TOTAL		478	186

SCENARIO NUMBER 3 TOR BVENT & 3 GATES

FLOODPLAIN & KHALS 1.53 KG/HA/10 DAYS FLOODPLAIN PRODUCTION 55.3 KG/HA/YEAR
FLOODPLAIN PRODUCT 126 TONS
BEEL PRODUCT 75 TONS

MONTH	DAY	AREA FLOODPLAIN BEEL HA	AREA SCENARIO EXIST BEEL HA	FLOODPLAIN PRODUCT TONS/YEAR	BEEL PRODUCT TONS/YEAR	REL BEEL PRODUCT (KG/HA/10 Days)
JAN	10	0	400	0.0	2.9	12.0
JAN	20	0	400	0.0	10.3	42.0
JAN	30	0	300	0.0	10.3	56.1
FEB	10	0	300	0.0	10.3	56.1
FEB	20	0	300	0.0	8.9	48.8
FEB	30	0	200	0.0	8.9	73.2
MAR	10	0	200	0.0	8.9	73.2
MAR	20	0	180	0.0	1.7	15.7
MAR	30	0	180	0.0	1.7	15.7
APR	10	0	170	0.0	1.7	16.6
APR	20	0	170	0.0	0.0	0.0
APR	30	0	150	0.0	0.0	0.0
MAY	10	0	150	0.0	0.0	0.0
MAY	20	0	1188	0.0	1.1	1.5
MAY	30	0	1539	0.0	1.4	1.5
JUN	10	0	1017	0.0	0.9	1.5
JUN	20	3058	0	4.7	0.0	0.0
JUN	30	4072	0	6.2	0.0	0.0
JUL	10	4915	0	7.5	0.0	0.0
JUL	20	8618	0	13.2	0.0	0.0
JUL	30	8483	0	13.0	0.0	0.0
AUG	10	5345	0	8.2	0.0	0.0
AUG	20	6161	0	9.5	0.0	0.0
AUG	30	6507	0	10.0	0.0	0.0
SEP	10	6591	0	10.1	0.0	0.0
SEP	20	7330	0	11.3	0.0	0.0
SEP	30	7281	0	11.2	0.0	0.0
OCT	10	5814	0	8.9	0.0	0.0
OCT	20	4760	0	7.3	0.0	0.0
OCT	30	2224	0	3.4	0.0	0.0
NOV	10	719	0	1.1	0.0	0.0
NOV	20	0	700	0.0	0.3	0.6
NOV	30	0	500	0.0	0.2	0.8
DEC	10	0	400	0.0	0.3	1.2
DEC	20	0	400	0.0	2.3	9.6
DEC	30	0	400	0.0	2.9	12.0

SPECIES WIDE PRODUCTION FIGURES
SCENARIO 3 TOR 8 VENT & 3 GATES

SPECIES	PRODUCTION PRINCIPAL RIVERS (%)	PRODUCTION MINOR RIVERS (%)	PRODUCTION BEEL (%)	PRODUCTION FLOODPLAIN (%)	PRODUCTION PONDS (%)	PRODUCTION TOTAL HABITATS (%)
MAJOR CARP	2.1	6.3	8.4	2.2	16.4	4.7
MINOR CARP	2.1	0.5	8.6	0.0	33.2	7.6
CATFISH	1.1	0.5	12.5	9.6	9.3	9.2
LIVE FISH	0.0	4.5	6.3	2.9	11.6	5.1
HILSA	23.4	0.0	0.0	0.0	0.0	0.3
MACROBRACHIUM	0.0	0.0	0.0	0.0	0.0	0.0
SMALL SHRIMP	10.6	2.0	3.8	0.0	0.0	0.6
MISCELANUOUS	60.6	86.3	60.4	85.3	29.4	72.5
TOTAL	100	100	100	100	100	100

SPECIES	PRODUCTION PRINCIPAL RIVERS (TON/YEAR)	PRODUCTION MINOR RIVERS (TON/YEAR)	PRODUCTION BEEL (TON/YEAR)	PRODUCTION FLOODPLAIN (TON/YEAR)	PRODUCTION PONDS (TON/YEAR)	PRODUCTION PITS & DER PONDS (TON/YEAR)	PRODUCTION TOTAL HABITATS (TON/YEAR)
MAJOR CARP	0.6	0.9	6.3	2.8	6.6	0.6	17.7
MINOR CARP	0.6	0.1	6.4	0.0	13.3	0.0	20.4
CATFISH	0.3	0.1	9.4	12.1	3.7	2.5	28.1
LIVE FISH	0.0	0.6	4.7	3.7	4.6	0.8	14.4
HILSA	7.0	0.0	0.0	0.0	0.0	0.0	7.0
MACROBRACHIUM	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SMALL SHRIMP	3.2	0.3	2.8	0.0	0.0	0.0	6.3
MISCELANUOUS	18.2	12.1	45.3	107.5	11.8	22.2	217.0
TOTAL	30	14	75	126	40	26	311

SPECIES	PRICE TK/KG	ECONOMIC VALUE US$ 1000	ECONOMIC VALUE TK (1hk)
MAJOR CARP	60	27	11
MINOR CARP	50	26	10
CATFISH	90	65	25
LIVE FISH	100	37	14
HILSA	100	18	7
MACROBRACHIUM	120	0	0
SMALL SHRIMP	40	6	3
MISCELANUOUS	40	223	87
TOTAL		402	157

SCENARIO NUMBER 4: TOR 4 VENT INLET & 3 GATES

FLOODPLAIN & KHALS 1.53 KG/HA/10 DAYS FLOODPLAIN PRODUCTION 55.3 KG/HA/YEAR

FLOODPLAIN PRODUCT 113 TONS
BEEL PRODUCT 59 TONS

MONTH	DAY	AREA FLOODPLAIN HA	BEEL AREA SCENARIO HA	EXIST BEEL AREA HA	FLOODPLAIN PRODUCT TONS/YEAR	BEEL PRODUCT TONS/YEAR	REL BEEL PRODUCT (KG/HA/10 Days)
JAN	10	0	400	400	0.0	2.3	12.0
JAN	20	0	400	400	0.0	8.1	42.0
JAN	30	0	300	300	0.0	8.1	56.1
FEB	10	0	300	300	0.0	8.1	56.1
FEB	20	0	300	300	0.0	7.0	48.8
FEB	30	0	200	200	0.0	7.0	73.2
MAR	10	0	200	200	0.0	7.0	73.2
MAR	20	0	180	180	0.0	1.4	15.7
MAR	30	0	170	180	0.0	1.3	15.7
APR	10	0	170	170	0.0	1.4	16.6
APR	20	0	150	170	0.0	0.0	0.0
APR	30	0	150	150	0.0	0.0	0.0
MAY	10	0	150	150	0.0	0.0	0.0
MAY	20	0	801	1084	0.0	0.6	1.5
MAY	30	0	1551	1611	0.0	1.1	1.5
JUN	10	0	800	1666	0.0	0.6	1.5
JUN	20	2772	0	0	4.3	0.0	0.0
JUN	30	3590	0	0	5.5	0.0	0.0
JUL	10	4771	0	0	7.3	0.0	0.0
JUL	20	7577	0	0	11.6	0.0	0.0
JUL	30	7479	0	0	11.5	0.0	0.0
AUG	10	4797	0	0	7.4	0.0	0.0
AUG	20	5564	0	0	8.5	0.0	0.0
AUG	30	5790	0	0	8.9	0.0	0.0
SEP	10	5908	0	0	9.1	0.0	0.0
SEP	20	6487	0	0	10.0	0.0	0.0
SEP	30	6624	0	0	10.2	0.0	0.0
OCT	10	5315	0	0	8.2	0.0	0.0
OCT	20	4555	0	0	7.0	0.0	0.0
OCT	30	1985	0	0	3.0	0.0	0.0
NOV	10	571	0	0	0.9	0.0	0.0
NOV	20	0	500	2000	0.0	0.1	0.6
NOV	30	0	450	1500	0.0	0.2	0.8
DEC	10	0	450	1000	0.0	0.3	1.2
DEC	20	0	400	500	0.0	1.8	9.6
DEC	30	0	400	400	0.0	2.3	12.0

SPECIES WIDE PRODUCTION FIGURES
SCENARIO 4: TOR 4 VENT INLET & 3 GATES

SPECIES	PRODUCTION PRINCIPAL RIVERS (%)	PRODUCTION MINOR RIVERS (%)	PRODUCTION BEEL (%)	PRODUCTION FLOODPLAIN (%)	PRODUCTION PONDS (%)	PRODUCTION TOTAL HABITATS (%)
MAJOR CARP	2.1	6.3	8.4	2.2	16.4	4.7
MINOR CARP	2.1	0.5	8.6	0.0	33.2	7.6
CATFISH	1.1	0.5	12.5	9.6	9.3	9.2
LIVE FISH	0.0	4.5	6.3	2.9	11.6	5.1
HILSA	23.4	0.0	0.0	0.0	0.0	0.3
MACROBRACHIUM	0.0	0.0	0.0	0.0	0.0	0.0
SMALL SHRIMP	10.6	2.0	3.8	0.0	0.0	0.6
MISCELANUOUS	60.6	86.3	60.4	85.3	29.4	72.5
TOTAL	100	100	100	100	100	100

SPECIES	PRODUCTION PRINCIPAL RIVERS (TON/YEAR)	PRODUCTION MINOR RIVERS (TON/YEAR)	PRODUCTION BEEL (TON/YEAR)	PRODUCTION FLOODPLAIN (TON/YEAR)	PRODUCTION PONDS (TON/YEAR)	PRODUCTION PITS & DER PONDS (TON/YEAR)	PRODUCTION TOTAL HABITATS (TON/YEAR)
MAJOR CARP	0.6	0.9	5.0	2.5	6.6	0.6	16.1
MINOR CARP	0.6	0.1	5.1	0.0	13.3	0.0	19.1
CATFISH	0.3	0.1	7.4	10.8	3.7	2.5	24.9
LIVE FISH	0.0	0.6	3.7	3.3	4.6	0.8	13.0
HILSA	7.0	0.0	0.0	0.0	0.0	0.0	7.0
MACROBRACHIUM	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SMALL SHRIMP	3.2	0.3	2.2	0.0	0.0	0.0	5.7
MISCELANUOUS	18.2	12.1	35.7	96.4	11.8	22.2	196.3
TOTAL	30	14	59	113	40	26	282

SPECIES	PRICE TK/KG	ECONOMIC VALUE US$ 1000	ECONOMIC VALUE TK (lhk)
MAJOR CARP	60	25	10
MINOR CARP	50	24	10
CATFISH	90	57	22
LIVE FISH	100	33	13
HILSA	100	18	7
MACROBRACHIUM	120	0	0
SMALL SHRIMP	40	6	2
MISCELANUOUS	40	201	79
TOTAL		365	142

SCENARIO NUMBER 5: 5 TOR THROTTLED & 3 THROTTLES

FLOODPLAIN & KHALS 1.535 KG/HA/10 DAYS FLOODPLAIN PRODUCTION 55.3 KG/HA/YEAR

FLOODPLAIN PRODUCT 156 TONS
BEEL PRODUCT 76 TONS

MONTH	DAY	AREA FLOODPLAIN BEEL HA	AREA SCENARIO BEEL HA	AREA EXIST BEEL HA	FLOODPLAIN PRODUCTION TONS/YEAR	BEEL PRODUCT TONS/YEAR	REL BEEL PRODUCT (KG/HA/10 Days)
JAN	10	0	400	400	0.0	2.9	12.0
JAN	20	0	400	400	0.0	10.1	42.0
JAN	30	0	300	300	0.0	10.1	56.1
FEB	10	0	300	300	0.0	10.1	56.1
FEB	20	0	300	300	0.0	8.8	48.8
FEB	30	0	200	200	0.0	8.8	73.2
MAR	10	0	200	200	0.0	8.8	73.2
MAR	20	0	180	180	0.0	1.7	15.7
MAR	30	0	180	180	0.0	1.7	15.7
APR	10	0	170	170	0.0	1.7	16.6
APR	20	0	170	170	0.0	0.0	0.0
APR	30	0	150	150	0.0	0.0	0.0
MAY	10	0	150	150	0.0	0.0	0.0
MAY	20	0	812	1084	0.0	1.2	1.5
MAY	30	0	1740	1611	0.0	2.7	1.5
JUN	10	0	997	1666	0.0	1.5	1.5
JUN	20	4600	0	0	7.1	0.0	0.0
JUN	30	6148	0	0	9.4	0.0	0.0
JUL	10	7113	0	0	10.9	0.0	0.0
JUL	20	9501	0	0	14.6	0.0	0.0
JUL	30	9347	0	0	14.3	0.0	0.0
AUG	10	7467	0	0	11.5	0.0	0.0
AUG	20	8141	0	0	12.5	0.0	0.0
AUG	30	8238	0	0	12.6	0.0	0.0
SEP	10	8075	0	0	12.4	0.0	0.0
SEP	20	8852	0	0	13.6	0.0	0.0
SEP	30	8557	0	0	13.1	0.0	0.0
OCT	10	7185	0	0	11.0	0.0	0.0
OCT	20	5323	0	0	8.2	0.0	0.0
OCT	30	2686	0	0	4.1	0.0	0.0
NOV	10	704	0	0	1.1	0.0	0.0
NOV	20	0	574	2000	0.0	0.2	0.6
NOV	30	0	498	1500	0.0	0.2	0.8
DEC	10	0	400	1000	0.0	0.3	1.2
DEC	20	0	400	500	0.0	2.3	9.6
DEC	30	0	400	400	0.0	2.9	12.0

SPECIES WIDE PRODUCTION FIGURES
SCENARIO 5: TOR THROTTLED & 3 THROTTLES

SPECIES	PRODUCTION PRINCIPAL RIVERS (%)	PRODUCTION MINOR RIVERS (%)	PRODUCTION BEEL (%)	PRODUCTION FLOODPLAIN (%)	PRODUCTION PONDS (%)	PRODUCTION TOTAL HABITATS (%)
MAJOR CARP	2.1	6.3	8.4	2.2	16.4	4.7
MINOR CARP	2.1	0.5	8.6	0.0	33.2	7.6
CATFISH	1.1	0.5	12.5	9.6	9.3	9.2
LIVE FISH	0.0	4.5	6.3	2.9	11.6	5.1
HILSA	23.4	0.0	0.0	0.0	0.0	0.3
MACROBRACHIUM	0.0	0.0	0.0	0.0	0.0	0.0
SMALL SHRIMP	10.6	2.0	3.8	0.0	0.0	0.6
MISCELANUOUS	60.6	86.3	60.4	85.3	29.4	72.5
TOTAL	100	100	100	100	100	100

SPECIES	PRODUCTION PRINCIPAL RIVERS (TON/YEAR)	PRODUCTION MINOR RIVERS (TON/YEAR)	PRODUCTION BEEL (TON/YEAR)	PRODUCTION FLOODPLAIN (TON/YEAR)	PRODUCTION PONDS (TON/YEAR)	PRODUCTION PITS & DER PONDS (TON/YEAR)	PRODUCTION TOTAL HABITATS (TON/YEAR)
MAJOR CARP	0.6	0.9	6.4	3.4	6.6	0.6	18.5
MINOR CARP	0.6	0.1	6.5	0.0	13.3	0.0	20.5
CATFISH	0.3	0.1	9.5	15.0	3.7	2.5	31.1
LIVE FISH	0.0	0.6	4.8	4.5	4.6	0.8	15.3
HILSA	7.0	0.0	0.0	0.0	0.0	0.0	7.0
MACROBRACHIUM	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SMALL SHRIMP	3.2	0.3	2.9	0.0	0.0	0.0	6.4
MISCELANUOUS	18.2	12.1	45.9	133.1	11.8	22.2	243.2
TOTAL	30	14	76	156	40	26	342

SPECIES	PRICE TK/KG	ECONOMIC VALUE US$ 1000	ECONOMIC VALUE TK (lhk)
MAJOR CARP	60	28	11
MINOR CARP	50	26	10
CATFISH	90	72	28
LIVE FISH	100	39	15
HILSA	100	18	7
MACROBRACHIUM	120	0	0
SMALL SHRIMP	40	7	3
MISCELANUOUS	40	249	97
TOTAL		440	171

SPECIES WIDE PRODUCTION FIGURES
SCENARIO 5: TOR THROTTLED & 3 THROTTLES

SPECIES	PRODUCTION PRINCIPAL RIVERS (%)	PRODUCTION MINOR RIVERS (%)	PRODUCTION BEEL (%)	PRODUCTION FLOODPLAIN (%)	PRODUCTION PONDS (%)	PRODUCTION TOTAL HABITATS (%)
MAJOR CARP	2.1	6.3	8.4	2.2	16.4	4.7
MINOR CARP	2.1	0.5	8.6	0.0	33.2	7.6
CATFISH	1.1	0.5	12.5	9.6	9.3	9.2
LIVE FISH	0.0	4.5	6.3	2.9	11.6	5.1
HILSA	23.4	0.0	0.0	0.0	0.0	0.3
MACROBRACHIUM	0.0	0.0	0.0	0.0	0.0	0.0
SMALL SHRIMP	10.6	2.0	3.8	0.0	0.0	0.6
MISCELANUOUS	60.6	86.3	60.4	85.3	29.4	72.5
TOTAL	100	100	100	100	100	100

SPECIES	PRODUCTION PRINCIPAL RIVERS (TON/YEAR)	PRODUCTION MINOR RIVERS (TON/YEAR)	PRODUCTION BEEL (TON/YEAR)	PRODUCTION FLOODPLAIN (TON/YEAR)	PRODUCTION PONDS (TON/YEAR)	PRODUCTION PITS & DER PONDS (TON/YEAR)	PRODUCTION TOTAL HABITATS (TON/YEAR)
MAJOR CARP	0.6	0.9	6.4	3.4	6.6	0.6	18.5
MINOR CARP	0.6	0.1	6.5	0.0	13.3	0.0	20.5
CATFISH	0.3	0.1	9.5	15.0	3.7	2.5	31.1
LIVE FISH	0.0	0.6	4.8	4.5	4.6	0.8	15.3
HILSA	7.0	0.0	0.0	0.0	0.0	0.0	7.0
MACROBRACHIUM	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SMALL SHRIMP	3.2	0.3	2.9	0.0	0.0	0.0	6.4
MISCELANUOUS	18.2	12.1	45.9	133.1	11.8	22.2	243.2
TOTAL	30	14	76	156	40	26	342

SPECIES	PRICE TK/KG	ECONOMIC VALUE US$ 1000	TK (1hk)
MAJOR CARP	60	28	11
MINOR CARP	50	26	10
CATFISH	90	72	28
LIVE FISH	100	39	15
HILSA	100	18	7
MACROBRACHIUM	120	0	0
SMALL SHRIMP	40	7	3
MISCELANUOUS	40	249	97
TOTAL		440	171

SCENARIO NUMBER 6: TOR V. INLET & 3 GATES & 3 INLETS

FLOODPLAIN & KHALS 1.535 KG/HA/10 DAYS FLOODPLAIN PRODUCTION 55.3 KG/HA/YEAR

FLOODPLAIN PRODUCT 145 TONS
BEEL PRODUCT 254 TONS

MONTH	DAY	AREA FLOODPLAIN BEEL HA	AREA SCENARIO EXIST BEEL HA	FLOODPLAIN PRODUCTION TONS/YEAR	BEEL PRODUCTION TONS/YEAR	REL BEEL PRODUCT (KG/HA/10 Days)
JAN	10	0	400	0.0	9.4	12.0
JAN	20	0	400	0.0	33.0	42.0
JAN	30	0	300	0.0	33.1	56.1
FEB	10	0	300	0.0	33.1	56.1
FEB	20	0	300	0.0	28.8	48.8
FEB	30	0	200	0.0	28.8	73.2
MAR	10	0	200	0.0	28.8	73.2
MAR	20	0	180	0.0	5.6	15.7
MAR	30	0	180	0.0	5.6	15.7
APR	10	0	170	0.0	5.5	16.6
APR	20	0	170	0.0	0.0	0.0
APR	30	0	150	0.0	0.0	0.0
MAY	10	0	150	0.0	0.0	0.0
MAY	20	0	3861	0.0	5.9	1.5
MAY	30	0	3911	0.0	6.0	1.5
JUN	10	0	3272	0.0	5.0	1.5
JUN	20	4136	0	6.3	0.0	0.0
JUN	30	4122	0	6.3	0.0	0.0
JUL	10	5069	0	7.8	0.0	0.0
JUL	20	8835	0	13.6	0.0	0.0
JUL	30	8889	0	13.6	0.0	0.0
AUG	10	6659	0	10.2	0.0	0.0
AUG	20	7149	0	11.0	0.0	0.0
AUG	30	7424	0	11.4	0.0	0.0
SEP	10	7331	0	11.3	0.0	0.0
SEP	20	8288	0	12.7	0.0	0.0
SEP	30	8275	0	12.7	0.0	0.0
OCT	10	6463	0	9.9	0.0	0.0
OCT	20	5628	0	8.6	0.0	0.0
OCT	30	3891	0	6.0	0.0	0.0
NOV	10	2540	0	3.9	0.0	0.0
NOV	20	0	2000	0.0	2.4	0.6
NOV	30	0	1500	0.0	2.4	0.8
DEC	10	0	1000	0.0	2.4	1.2
DEC	20	0	500	0.0	9.4	9.6
DEC	30	0	400	0.0	9.4	12.0

SPECIES WIDE PRODUCTION FIGURES
SCENARIO 6: TOR V INLET & 3 GATES & 3 INLETS

SPECIES	PRODUCTION PRINCIPAL RIVERS (%)	PRODUCTION MINOR RIVERS (%)	PRODUCTION BEEL (%)	PRODUCTION FLOODPLAIN (%)	PRODUCTION PONDS (%)	PRODUCTION TOTAL HABITATS (%)
MAJOR CARP	2.1	6.3	8.4	2.2	16.4	4.7
MINOR CARP	2.1	0.5	8.6	0.0	33.2	7.6
CATFISH	1.1	0.5	12.5	9.6	9.3	9.2
LIVE FISH	0.0	4.5	6.3	2.9	11.6	5.1
HILSA	23.4	0.0	0.0	0.0	0.0	0.3
MACROBRACHIUM	0.0	0.0	0.0	0.0	0.0	0.0
SMALL SHRIMP	10.6	2.0	3.8	0.0	0.0	0.6
MISCELANUOUS	60.6	86.3	60.4	85.3	29.4	72.5
TOTAL	100	100	100	100	100	100

SPECIES	PRODUCTION PRINCIPAL RIVERS (TON/YEAR)	PRODUCTION MINOR RIVERS (TON/YEAR)	PRODUCTION BEEL (TON/YEAR)	PRODUCTION FLOODPLAIN (TON/YEAR)	PRODUCTION PONDS (TON/YEAR)	PRODUCTION PITS & DER PONDS (TON/YEAR)	PRODUCTION TOTAL HABITATS (TON/YEAR)
MAJOR CARP	0.6	0.9	21.3	3.2	6.6	0.6	33.2
MINOR CARP	0.6	0.1	21.8	0.0	13.3	0.0	35.8
CATFISH	0.3	0.1	31.9	13.9	3.7	2.5	52.4
LIVE FISH	0.0	0.6	15.9	4.2	4.6	0.8	26.1
HILSA	7.0	0.0	0.0	0.0	0.0	0.0	7.0
MACROBRACHIUM	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SMALL SHRIMP	3.2	0.3	9.6	0.0	0.0	0.0	13.1
MISCELANUOUS	18.2	12.1	153.5	123.7	11.8	22.2	341.4
TOTAL	30	14	254	145	40	26	509

SPECIES	PRICE TK/KG	ECONOMIC VALUE US$ 1000	ECONOMIC VALUE TK (1hk)
MAJOR CARP	80	68	27
MINOR CARP	70	64	25
CATFISH	45	60	24
LIVE FISH	45	30	12
HILSA	100	18	7
MACROBRACHIUM	100	0	0
SMALL SHRIMP	30	10	4
MISCELANUOUS	30	263	102
TOTAL		514	200

SCENARIO NUMBER 7: FAP GATED 8 VENTS & 4 GATES

FLOODPLAIN & KHALS 1.535 KG/HA/10 DAYS FLOODPLAIN PRODUCTION 55.3 KG/HA/YEAR

FLOODPLAIN PRODUCT 127 TONS
BEEL PRODUCT 85 TONS BEEL PRODUCTION

MONTH	DAY	AREA FLOODPLAIN BEEL HA	AREA SCENARIO BEEL HA	AREA EXIST BEEL HA	FLOODPLAIN PRODUCTION TONS/YEAR	BEEL PRODUCTION TONS/YEAR	REL BEEL PRODUCT (KG/HA/10 Days)
JAN	10	0	400	400	0.0	3.3	12.0
JAN	20	0	400	400	0.0	11.4	42.0
JAN	30	0	300	300	0.0	11.4	56.1
FEB	10	0	300	300	0.0	11.4	56.1
FEB	20	0	300	300	0.0	9.9	48.8
FEB	30	0	200	200	0.0	9.9	73.2
MAR	10	0	200	200	0.0	9.9	73.2
MAR	20	0	180	180	0.0	1.9	15.7
MAR	30	0	180	180	0.0	1.9	15.7
APR	10	0	170	170	0.0	1.9	16.6
APR	20	0	170	170	0.0	0.0	0.0
APR	30	0	150	150	0.0	0.0	0.0
MAY	10	0	150	150	0.0	0.0	0.0
MAY	20	0	964	1084	0.0	1.5	1.5
MAY	30	0	1890	1611	0.0	2.9	1.5
JUN	10	0	1131	1666	0.0	1.7	1.5
JUN	20	3067	0	0	4.7	0.0	0.0
JUN	30	4055	0	0	6.2	0.0	0.0
JUL	10	5166	0	0	7.9	0.0	0.0
JUL	20	8614	0	0	13.2	0.0	0.0
JUL	30	8486	0	0	13.0	0.0	0.0
AUG	10	5370	0	0	8.2	0.0	0.0
AUG	20	6192	0	0	9.5	0.0	0.0
AUG	30	6587	0	0	10.1	0.0	0.0
SEP	10	6562	0	0	10.1	0.0	0.0
SEP	20	7337	0	0	11.3	0.0	0.0
SEP	30	7586	0	0	11.6	0.0	0.0
OCT	10	5828	0	0	8.9	0.0	0.0
OCT	20	5126	0	0	7.9	0.0	0.0
OCT	30	2201	0	0	3.4	0.0	0.0
NOV	10	706	0	0	1.1	0.0	0.0
NOV	20	0	570	2000	0.0	0.2	0.6
NOV	30	0	493	1500	0.0	0.3	0.8
DEC	10	0	400	1000	0.0	0.3	1.2
DEC	20	0	400	500	0.0	2.6	9.6
DEC	30	0	300	400	0.0	2.4	12.0

SPECIES WIDE PRODUCTION FIGURES
SCENARIO 7: FAP GATED 8 VENTS & 4 GATES

SPECIES	PRODUCTION PRINCIPAL RIVERS (%)	PRODUCTION MINOR RIVERS (%)	PRODUCTION BEEL (%)	PRODUCTION FLOODPLAIN (%)	PRODUCTION PONDS (%)	PRODUCTION TOTAL HABITATS (%)
MAJOR CARP	2.1	6.3	8.4	2.2	16.4	4.7
MINOR CARP	2.1	0.5	8.6	0.0	33.2	7.6
CATFISH	1.1	0.5	12.5	9.6	9.3	9.2
LIVE FISH	0.0	4.5	6.3	2.9	11.6	5.1
HILSA	23.4	0.0	0.0	0.0	0.0	0.3
MACROBRACHIUM	0.0	0.0	0.0	0.0	0.0	0.0
SMALL SHRIMP	10.6	2.0	3.8	0.0	0.0	0.6
MISCELANUOUS	60.6	86.3	60.4	85.3	29.4	72.5
TOTAL	100	100	100	100	100	100

SPECIES	PRODUCTION PRINCIPAL RIVERS (TON/YEAR)	PRODUCTION MINOR RIVERS (TON/YEAR)	PRODUCTION BEEL (TON/YEAR)	PRODUCTION FLOODPLAIN (TON/YEAR)	PRODUCTION PONDS (TON/YEAR)	PRODUCTION PITS & DER PONDS (TON/YEAR)	PRODUCTION TOTAL HABITATS (TON/YEAR)
MAJOR CARP	0.6	0.9	7.1	2.8	6.6	0.6	18.6
MINOR CARP	0.6	0.1	7.3	0.0	13.3	0.0	21.3
CATFISH	0.3	0.1	10.7	12.2	3.7	2.5	29.5
LIVE FISH	0.0	0.6	5.3	3.7	4.6	0.8	15.0
HILSA	7.0	0.0	0.0	0.0	0.0	0.0	7.0
MACROBRACHIUM	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SMALL SHRIMP	3.2	0.3	3.2	0.0	0.0	0.0	6.7
MISCELANUOUS	18.2	12.1	51.4	108.3	11.8	22.2	223.9
TOTAL	30	14	85	127	40	26	322

SPECIES	PRICE TK/KG	ECONOMIC VALUE US$ 1000	TK (1hk)
MAJOR CARP	60	29	11
MINOR CARP	50	27	11
CATFISH	90	68	27
LIVE FISH	100	38	15
HILSA	100	18	7
MACROBRACHIUM	120	0	0
SMALL SHRIMP	40	7	3
MISCELANUOUS	40	230	90
TOTAL		417	163

SCENARIO NUMBER 8: TOR INLET THROTTLE &LOH/COMP
THROTTLE & SUBCOMP THROTTLE
FLOODPLAIN & KHALS 1.535 KG/HA/10 DAYS FLOODPLAIN PRODUCTION 55.3 KG/HA/YEAR

FLOODPLAIN PRODUCT 148 TONS
BEEL PRODUCT 85 TONS BEEL PRODUCTION

MONTH	DAY	AREA FLOODPLAIN BEEL HA	AREA SCENARIO BEEL HA	AREA EXIST HA	FLOODPLAIN PRODUCTION TONS/YEAR	BEEL PRODUCTION TONS/YEAR	REL BEEL PRODUCT (KG/HA/10 Days)
JAN	10	0	400	400	0.0	3.3	12.0
JAN	20	0	400	400	0.0	11.4	42.0
JAN	30	0	300	300	0.0	11.4	56.1
FEB	10	0	300	300	0.0	11.4	56.1
FEB	20	0	300	300	0.0	9.9	48.8
FEB	30	0	200	200	0.0	9.9	73.2
MAR	10	0	200	200	0.0	9.9	73.2
MAR	20	0	180	180	0.0	1.9	15.7
MAR	30	0	180	180	0.0	1.9	15.7
APR	10	0	170	170	0.0	1.9	16.6
APR	20	0	170	170	0.0	0.0	0.0
APR	30	0	150	150	0.0	0.0	0.0
MAY	10	0	150	150	0.0	0.0	0.0
MAY	20	0	964	1084	0.0	1.5	1.5
MAY	30	0	1890	1611	0.0	2.9	1.5
JUN	10	0	1131	1666	0.0	1.7	1.5
JUN	20	4370	0	0	6.7	0.0	0.0
JUN	30	5759	0	0	8.8	0.0	0.0
JUL	10	6351	0	0	9.7	0.0	0.0
JUL	20	9594	0	0	14.7	0.0	0.0
JUL	30	9499	0	0	14.6	0.0	0.0
AUG	10	6851	0	0	10.5	0.0	0.0
AUG	20	7288	0	0	11.2	0.0	0.0
AUG	30	7547	0	0	11.6	0.0	0.0
SEP	10	7413	0	0	11.4	0.0	0.0
SEP	20	8181	0	0	12.6	0.0	0.0
SEP	30	8137	0	0	12.5	0.0	0.0
OCT	10	6963	0	0	10.7	0.0	0.0
OCT	20	4844	0	0	7.4	0.0	0.0
OCT	30	2499	0	0	3.8	0.0	0.0
NOV	10	1178	0	0	1.8	0.0	0.0
NOV	20	0	1095	2000	0.0	0.4	0.6
NOV	30	0	514	1500	0.0	0.3	0.8
DEC	10	0	400	1000	0.0	0.3	1.2
DEC	20	0	400	500	0.0	2.6	9.6
DEC	30	0	300	400	0.0	2.4	12.0

SPECIES WIDE PRODUCTION FIGURES
SCENARIO 8: TOR INLET THROTTLE & LOH/COMP THROTTLE & SUBCOMP THROTTLE

SPECIES	PRODUCTION PRINCIPAL RIVERS (%)	PRODUCTION MINOR RIVERS (%)	PRODUCTION BEEL (%)	PRODUCTION FLOODPLAIN (%)	PRODUCTION PONDS (%)	PRODUCTION TOTAL HABITATS (%)
MAJOR CARP	2.1	6.3	8.4	2.2	16.4	4.7
MINOR CARP	2.1	0.5	8.6	0.0	33.2	7.6
CATFISH	1.1	0.5	12.5	9.6	9.3	9.2
LIVE FISH	0.0	4.5	6.3	2.9	11.6	5.1
HILSA	23.4	0.0	0.0	0.0	0.0	0.3
MACROBRACHIUM	0.0	0.0	0.0	0.0	0.0	0.0
SMALL SHRIMP	10.6	2.0	3.8	0.0	0.0	0.6
MISCELANUOUS	60.6	86.3	60.4	85.3	29.4	72.5
TOTAL	100	100	100	100	100	100

SPECIES	PRODUCTION PRINCIPAL RIVERS (TON/YEAR)	PRODUCTION MINOR RIVERS (TON/YEAR)	PRODUCTION BEEL (TON/YEAR)	PRODUCTION FLOODPLAIN (TON/YEAR)	PRODUCTION PONDS (TON/YEAR)	PRODUCTION PITS & DER PONDS (TON/YEAR)	PRODUCTION TOTAL HABITATS (TON/YEAR)
MAJOR CARP	0.6	0.9	7.1	3.3	6.6	0.6	19.1
MINOR CARP	0.6	0.1	7.3	0.0	13.3	0.0	21.3
CATFISH	0.3	0.1	10.7	14.2	3.7	2.5	31.5
LIVE FISH	0.0	0.6	5.3	4.3	4.6	0.8	15.6
HILSA	7.0	0.0	0.0	0.0	0.0	0.0	7.0
MACROBRACHIUM	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SMALL SHRIMP	3.2	0.3	3.2	0.0	0.0	0.0	6.7
MISCELANUOUS	18.2	12.1	51.4	126.2	11.8	22.2	241.8
TOTAL	30	14	85	148	40	26	343

SPECIES	PRICE TK/KG	ECONOMIC VALUE US$ 1000	ECONOMIC VALUE TK (lhk)
MAJOR CARP	60	29	11
MINOR CARP	50	27	11
CATFISH	90	73	28
LIVE FISH	100	40	16
HILSA	100	18	7
MACROBRACHIUM	120	0	0
SMALL SHRIMP	40	7	3
MISCELANUOUS	40	248	97
TOTAL		442	172

SCENARIO NUMBER 9 PERIPHERAL CONTROL WITH OVERSPILL REGULATORS

FLOODPLAIN & KHALS 1.535 KG/HA/10 DAYS FLOODPLAIN PRODUCTION 55.3 KG/HA/YEAR
FLOODPLAIN PRODUCT 171 TONS
BEEL PRODUCTION 92 TONS

MONTH	DAY	AREA FLOODPLAIN HA	BEEL AREA SCENARIO HA	EXIST BEEL AREA HA	FLOODPLAIN PRODUCT TONS/YEAR	BEEL PRODUCT TONS/YEAR	REL BEEL PRODUCT (KG/HA/10 Days)
JAN	10	0	400	400	0.0	3.5	12.0
JAN	20	0	400	400	0.0	12.4	42.0
JAN	30	0	300	300	0.0	12.4	56.1
FEB	10	0	300	300	0.0	12.4	56.1
FEB	20	0	300	300	0.0	10.8	48.8
FEB	30	0	200	200	0.0	10.8	73.2
MAR	10	0	200	200	0.0	10.8	73.2
MAR	20	0	180	180	0.0	2.1	15.7
MAR	30	0	180	180	0.0	2.1	15.7
APR	10	0	170	170	0.0	2.1	16.6
APR	20	0	170	170	0.0	0.0	0.0
APR	30	0	150	150	0.0	0.0	0.0
MAY	10	0	150	150	0.0	0.0	0.0
MAY	20	0	750	1084	0.0	0.8	1.5
MAY	30	0	1609	1611	0.0	1.8	1.5
JUN	10	0	1226	1666	0.0	1.4	1.5
JUN	20	5288	0	0	8.1	0.0	0.0
JUN	30	7242	0	0	11.1	0.0	0.0
JUL	10	7773	0	0	11.9	0.0	0.0
JUL	20	10307	0	0	15.8	0.0	0.0
JUL	30	9911	0	0	15.2	0.0	0.0
AUG	10	8265	0	0	12.7	0.0	0.0
AUG	20	8927	0	0	13.7	0.0	0.0
AUG	30	8910	0	0	13.7	0.0	0.0
SEP	10	8958	0	0	13.7	0.0	0.0
SEP	20	9601	0	0	14.7	0.0	0.0
SEP	30	9020	0	0	13.8	0.0	0.0
OCT	10	7733	0	0	11.9	0.0	0.0
OCT	20	5721	0	0	8.8	0.0	0.0
OCT	30	2485	0	0	3.8	0.0	0.0
NOV	10	1172	0	0	1.8	0.0	0.0
NOV	20	0	1000	1000	0.0	0.4	0.6
NOV	30	0	800	800	0.0	0.5	0.8
DEC	10	0	700	700	0.0	0.6	1.2
DEC	20	0	500	500	0.0	3.5	9.6
DEC	30	0	400	400	0.0	3.5	12.0

SPECIES WIDE PRODUCTION FIGURES
SCENARIO 9 PERIPHERAL CONTROL WITH OVERSPILL REGULATORS

SPECIES	PRODUCTION PRINCIPAL RIVERS (%)	PRODUCTION MINOR RIVERS (%)	PRODUCTION BEEL (%)	PRODUCTION FLOODPLAIN (%)	PRODUCTION PONDS (%)	PRODUCTION TOTAL HABITATS (%)
MAJOR CARP	2.1	6.3	8.4	2.2	16.4	4.7
MINOR CARP	2.1	0.5	8.6	0.0	33.2	7.6
CATFISH	1.1	0.5	12.5	9.6	9.3	9.2
LIVE FISH	0.0	4.5	6.3	2.9	11.6	5.1
HILSA	23.4	0.0	0.0	0.0	0.0	0.3
MACROBRACHIUM	0.0	0.0	0.0	0.0	0.0	0.0
SMALL SHRIMP	10.6	2.0	3.8	0.0	0.0	0.6
MISCELANUOUS	60.6	86.3	60.4	85.3	29.4	72.5
TOTAL	100	100	100	100	100	100

SPECIES	PRODUCTION PRINCIPAL RIVERS (TON/YEAR)	PRODUCTION MINOR RIVERS (TON/YEAR)	PRODUCTION BEEL (TON/YEAR)	PRODUCTION FLOODPLAIN (TON/YEAR)	PRODUCTION PONDS (TON/YEAR)	PRODUCTION PITS & DER PONDS (TON/YEAR)	PRODUCTION TOTAL HABITATS (TON/YEAR)
MAJOR CARP	0.6	0.9	7.7	3.8	6.6	0.6	20.2
MINOR CARP	0.6	0.1	7.9	0.0	13.3	0.0	21.9
CATFISH	0.3	0.1	11.5	16.4	3.7	2.5	34.6
LIVE FISH	0.0	0.6	5.8	5.0	4.6	0.8	16.7
HILSA	7.0	0.0	0.0	0.0	0.0	0.0	7.0
MACROBRACHIUM	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SMALL SHRIMP	3.2	0.3	3.5	0.0	0.0	0.0	7.0
MISCELANUOUS	18.2	12.1	55.6	145.9	11.8	22.2	265.7
TOTAL	30	14	92	171	40	26	373

SPECIES	MARKET PRICE TK/KG	ECONOMIC VALUE US$ 1000	TK (lhk)
MAJOR CARP	80	41	16
MINOR CARP	70	39	15
CATFISH	45	40	16
LIVE FISH	45	19	8
HILSA	100	18	7
MACROBRACHIUM	100	0	0
SMALL SHRIMP	30	5	2
MISCELLANEOUS	40	273	106
TOTAL		436	170

SCENARIO NUMBER 10 PERIPHERAL AND INTERNAL CONTROL WITH OVERSPILL REGULATORS

FLOODPLAIN & KHALS 1.535 KG/HA/10 DAYS FLOODPLAIN PRODUCTION 55.3 KG/HA/YEAR
FLOODPLAIN PRODUCT 159 TONS
BEEL PRODUCTION 61 TONS

MONTH	DAY	AREA FLOODPLAIN BEEL HA	AREA SCENARIO EXIST BEEL HA	AREA FLOODPLAIN PRODUCT TONS/YEAR	BEEL PRODUCT TONS/YEAR	REL BEEL PRODUCT (KG/HA/10 Days)
JAN	10	0	300 400	0.0	1.9	12.0
JAN	20	0	300 400	0.0	6.8	42.0
JAN	30	0	300 300	0.0	9.1	56.1
FEB	10	0	300 300	0.0	9.1	56.1
FEB	20	0	200 300	0.0	5.3	48.8
FEB	30	0	200 200	0.0	7.9	73.2
MAR	10	0	200 200	0.0	7.9	73.2
MAR	20	0	180 180	0.0	1.5	15.7
MAR	30	0	180 180	0.0	1.5	15.7
APR	10	0	170 170	0.0	1.5	16.6
APR	20	0	170 170	0.0	0.0	0.0
APR	30	0	150 150	0.0	0.0	0.0
MAY	10	0	150 150	0.0	0.0	0.0
MAY	20	0	2687 1084	0.0	2.2	1.5
MAY	30	0	1899 1611	0.0	1.5	1.5
JUN	10	0	899 1666	0.0	0.7	1.5
JUN	20	4631	0 0	7.1	0.0	0.0
JUN	30	6702	0 0	10.3	0.0	0.0
JUL	10	7182	0 0	11.0	0.0	0.0
JUL	20	9281	0 0	14.2	0.0	0.0
JUL	30	9186	0 0	14.1	0.0	0.0
AUG	10	7859	0 0	12.1	0.0	0.0
AUG	20	8175	0 0	12.5	0.0	0.0
AUG	30	8673	0 0	13.3	0.0	0.0
SEP	10	8320	0 0	12.8	0.0	0.0
SEP	20	9028	0 0	13.9	0.0	0.0
SEP	30	8734	0 0	13.4	0.0	0.0
OCT	10	8081	0 0	12.4	0.0	0.0
OCT	20	5239	0 0	8.0	0.0	0.0
OCT	30	2044	0 0	3.1	0.0	0.0
NOV	10	530	0 0	0.8	0.0	0.0
NOV	20	0	500 2000	0.0	0.2	0.6
NOV	30	0	400 1500	0.0	0.2	0.8
DEC	10	0	400 1000	0.0	0.3	1.2
DEC	20	0	300 500	0.0	1.6	9.6
DEC	30	0	300 400	0.0	1.9	12.0

SPECIES WIDE PRODUCTION FIGURES
SCENARIO 10 PERIPHERAL AND INTERNAL CONTROL WITH OVERSPILL REGULATORS

SPECIES	PRODUCTION PRINCIPAL RIVERS (%)	PRODUCTION MINOR RIVERS (%)	PRODUCTION BEEL (%)	PRODUCTION FLOODPLAIN (%)	PRODUCTION PONDS (%)	PRODUCTION TOTAL HABITATS (%)
MAJOR CARP	2.1	6.3	8.4	2.2	16.4	4.7
MINOR CARP	2.1	0.5	8.6	0.0	33.2	7.6
CATFISH	1.1	0.5	12.5	9.6	9.3	9.2
LIVE FISH	0.0	4.5	6.3	2.9	11.6	5.1
HILSA	23.4	0.0	0.0	0.0	0.0	0.3
MACROBRACHIUM	0.0	0.0	0.0	0.0	0.0	0.0
SMALL SHRIMP	10.6	2.0	3.8	0.0	0.0	0.6
MISCELANUOUS	60.6	86.3	60.4	85.3	29.4	72.5
TOTAL	100	100	100	100	100	100

SPECIES	PRODUCTION PRINCIPAL RIVERS (TON/YEAR)	PRODUCTION MINOR RIVERS (TON/YEAR)	PRODUCTION BEEL (TON/YEAR)	PRODUCTION FLOODPLAIN (TON/YEAR)	PRODUCTION PONDS (TON/YEAR)	PRODUCTION PITS & DER PONDS (TON/YEAR)	PRODUCTION TOTAL HABITATS (TON/YEAR)
MAJOR CARP	0.6	0.9	5.1	3.5	6.6	0.6	17.3
MINOR CARP	0.6	0.1	5.2	0.0	13.3	0.0	19.2
CATFISH	0.3	0.1	7.7	15.3	3.7	2.5	29.5
LIVE FISH	0.0	0.6	3.8	4.6	4.6	0.8	14.4
HILSA	7.0	0.0	0.0	0.0	0.0	0.0	7.0
MACROBRACHIUM	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SMALL SHRIMP	3.2	0.3	2.3	0.0	0.0	0.0	5.8
MISCELANUOUS	18.2	12.1	36.9	135.6	11.8	22.2	236.7
TOTAL	30	14	61	159	40	26	330

SPECIES	MARKET PRICE TK/KG	ECONOMIC VALUE US$ 1000	ECONOMIC VALUE TK (lhk)
MAJOR CARP	60	27	10
MINOR CARP	50	25	10
CATFISH	90	68	27
LIVE FISH	100	37	14
HILSA	100	18	7
MACROBRACHIUM	120	0	0
SMALL SHRIMP	40	6	2
MISCELLANEOUS	40	243	95
TOTAL		423	165

SPECIES WIDE PRODUCTION FIGURES
SCENARIO 11 PERIPHERAL CONTROL WITH 50% OVERSPILL AND 50 % UNDERSHOT

SPECIES	PRODUCTION PRINCIPAL RIVERS (%)	PRODUCTION MINOR RIVERS (%)	PRODUCTION BEEL (%)	PRODUCTION FLOODPLAIN (%)	PRODUCTION PONDS (%)	PRODUCTION TOTAL HABITATS (%)
MAJOR CARP	2.1	3.9	5.4	1.3	16.4	4.7
MINOR CARP	2.1	0.3	5.5	0.0	33.2	7.6
CATFISH	1.1	0.5	13.5	9.7	9.3	9.2
LIVE FISH	0.0	4.6	6.7	2.9	11.6	5.1
HILSA	23.4	0.0	0.0	0.0	0.0	0.3
MACROBRACHIUM	0.0	0.0	0.0	0.0	0.0	0.0
SMALL SHRIMP	10.6	2.1	4.1	0.0	0.0	0.6
MISCELANUOUS	60.6	88.7	64.8	86.1	29.4	72.5
TOTAL	100	100	100	100	100	100

SPECIES	PRODUCTION PRINCIPAL RIVERS (TON/YEAR)	PRODUCTION MINOR RIVERS (TON/YEAR)	PRODUCTION BEEL (TON/YEAR)	PRODUCTION FLOODPLAIN (TON/YEAR)	PRODUCTION PONDS (TON/YEAR)	PRODUCTION PITS & DER PONDS (TON/YEAR)	PRODUCTION TOTAL HABITATS (TON/YEAR)
MAJOR CARP	0.6	0.5	4.6	2.3	6.6	0.3	15.0
MINOR CARP	0.6	0.0	4.7	0.0	13.3	0.0	18.7
CATFISH	0.3	0.1	11.5	16.4	3.7	2.5	34.6
LIVE FISH	0.0	0.6	5.8	5.0	4.6	0.8	16.7
HILSA	7.0	0.0	0.0	0.0	0.0	0.0	7.0
MACROBRACHIUM	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SMALL SHRIMP	3.2	0.3	3.5	0.0	0.0	0.0	7.0
MISCELANUOUS	18.2	12.1	55.6	145.9	11.8	22.2	265.7
TOTAL	30	14	86	169	40	26	365

SPECIES	MARKET PRICE TK/KG	ECONOMIC VALUE US$ 1000	ECONOMIC VALUE TK (1hk)
MAJOR CARP	80	31	12
MINOR CARP	70	34	13
CATFISH	45	40	16
LIVE FISH	45	19	8
HILSA	100	18	7
MACROBRACHIUM	100	0	0
SMALL SHRIMP	30	5	2
MISCELLANEOUS	40	273	106
TOTAL		419	164

SPECIES WIDE PRODUCTION FIGURES
SCENARIO 12 PERIPHERAL AND INTERNAL CONTROL WITH 50% OVERSPILL AND 50 % UNDERSHOT

SPECIES	PRODUCTION PRINCIPAL RIVERS (%)	PRODUCTION MINOR RIVERS (%)	PRODUCTION BEEL (%)	PRODUCTION FLOODPLAIN (%)	PRODUCTION PONDS (%)	PRODUCTION TOTAL HABITATS (%)
MAJOR CARP	2.1	3.9	5.4	1.3	16.4	4.7
MINOR CARP	2.1	0.3	5.5	0.0	33.2	7.6
CATFISH	1.1	0.5	13.5	9.7	9.3	9.2
LIVE FISH	0.0	4.6	6.7	2.9	11.6	5.1
HILSA	23.4	0.0	0.0	0.0	0.0	0.3
MACROBRACHIUM	0.0	0.0	0.0	0.0	0.0	0.0
SMALL SHRIMP	10.6	2.1	4.1	0.0	0.0	0.6
MISCELANUOUS	60.6	88.7	64.8	86.1	29.4	72.5
TOTAL	100.00	100.00	100.00	100.00	100.00	100.00

SPECIES	PRODUCTION PRINCIPAL RIVERS (TON/YEAR)	PRODUCTION MINOR RIVERS (TON/YEAR)	PRODUCTION BEEL (TON/YEAR)	PRODUCTION FLOODPLAIN (TON/YEAR)	PRODUCTION PONDS (TON/YEAR)	PRODUCTION PITS & DER PONDS (TON/YEAR)	PRODUCTION TOTAL HABITATS (TON/YEAR)
MAJOR CARP	0.6	0.5	3.1	2.1	6.6	0.3	13.3
MINOR CARP	0.6	0.0	3.1	0.0	13.3	0.0	17.1
CATFISH	0.3	0.1	7.7	15.3	3.7	2.5	29.5
LIVE FISH	0.0	0.6	3.8	4.6	4.6	0.8	14.4
HILSA	7.0	0.0	0.0	0.0	0.0	0.0	7.0
MACROBRACHIUM	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SMALL SHRIMP	3.2	0.3	2.3	0.0	0.0	0.0	5.8
MISCELANUOUS	18.2	12.1	36.9	135.6	11.8	22.2	236.7
TOTAL	30	14	57	158	40	26	324

SPECIES	MARKET PRICE TK/KG	ECONOMIC VALUE US$ 1000	TK (lhk)
MAJOR CARP	60.00	20	8
MINOR CARP	50.00	22	9
CATFISH	90.00	68	27
LIVE FISH	100.00	37	14
HILSA	100.00	18	7
MACROBRACHIUM	120.00	0	0
SMALL SHRIMP	40.00	6	2
MISCELLANEOUS	40.00	243	95
TOTAL		414	162

APPENDIX 4

BANGLADESH FLOOD ACTION PLAN

COMPARTMENTALIZATION PILOT PROJECT

FAP 20

TECHNICAL NOTE CPP FISHERIES STUDY

BENGALI, ENGLISH AND SCIENTIFIC FISH NAMES

NAMES OF FRESH WATER FISHES OF BANGLADESH

Source: **Rahman, 1989**

BENGALI NAME	ENGLISH NAME	SCIENTIFIC NAME
Along/Sephatia		Rasbora elanga
Angroth/Karsha		Labeo angra
Anju		Danio rerio
Apuia		Osteogeniosus militaris
Ayre		Mystus aor
Bacha		Eutropiichthys vacha
Baghair		Bagarius bagarius
Bailla		Glossogobius giuris
Baim	Spiny eel	Mastacembelus armatus
Bajari tengra		Mystus tengara
Balitora		Psilorhynchus balitora
Bamosh		Anguilla bengalensis
Bamosh	Mud eel	Ophisternon bengalensis
Bani/Koksa		Barilius barni
Barali		Barilius barila
Barang		Nematalosa nasus
Bata/Bhangon		Labeo bata
Bata	Mullet	Mugil dussumieri
Bata	Mullet	Mugil parsia
Bata	Mullet	Mugil oligolepsis
Batasi		Pseudoptrius atherinoides
Bele		Awaous stamineus
Bele/Bailla		Glossogobius giurus
Betrangi/Rani		
Bhagna/Raik		Cirrhinus reba
Bhangan		Labeo boga
Bheda		Nandus nandus
Bhol		Barilius bola
Bilturi	Loach	Nemachilus botia
Bishtara	Butterfish	Scatophagus argus
Boal	Catfish	Wallago attu
Bojri		
Budh Bailla		Eleotris fusca
Catla	Carp	Catla catla
Cenia/Jungla		Gagata cenia
Chaka		Chaca chaca
Chala punti		Puntius chola
Chanda		Chanda beculis
Chanda		Chanda ranga
Chanda		

Chandana		Hilsa toli
Chapila	Herring	Gudusia chapra
Chebli		Danio aequipinnatus
Cheka	Catfish	Chaca Chaca
Chewa	Skipper	Pseudopacryptes lanceolatus
Chewa		Taeniodes cirratus
Chingri chotka		
Chingri black		
Chingri		
Chiring	Skipper	Apocryptes bato
Chital		Nopterus chitala
Chital		Notopterus chitala
Chora chela	Minnow/Barb	Oxygaster gora
Chouka		Pellona ditchela
Choukka		Ilisha motius
Chuna/Khailsha	Perch	Colisa sota
Churi		Trichiurus muticus
Dahuk	Skipper	Boleophthalmus boddarti
Dahuk	Skipper	Cartelaos viridis
Dali chewa	Skipper	Parapocryptes batoides
Dankina/Along		
Dari	Loach	Nemachilus zonatus
Darkina	Minnow/Barb	Esomus danricus
Darkina		Rasbora daniconius
Debari/Chebli		Danio devario
Ek Thota	Half beak	Hyporchampus gimardi
Faissa		
Fali chanda	Pomfret	Pampus argentus
Foli		Nopterus nopterus
Fulchela	Minnow/Barb	Salmostoma phulo
Gachua/Raga	Snakehead	Channa orientalis
Gagla/Ghunga		Tachysurus gagora
Gajar	Snakehead	Channa marulius
Gang Magur	Catfish	Plotius canius
Gang tengra		Gagata viridescens
Gang tengra		Gagata nangra
Gang tengra		Gagata youssoufi
Ghagla/arwari		Mystus menoda
Ghainna/Goni		Labeo gonius
Ghar Poia	Carp	Garra gotyla
Ghaura		Clupisoma garua
Ghora maach		Labeo pangusia
Gilipunti		Puntius gelius
Goijar		Chana matrulins
Golsha tengra		Mystus bleekeri
Goni chapila		Gonialosa manminna

Guchi/Pankal	Spiny eel	Mastacembelus pancalus
Guchi		
Guizza		Mystus seenghala
Gutum		Lepidocephalus guntea
Hilsa		Hilsa ilisha
Hudda		Gagata gagata
Ilish		Hilsa ilisha
Jarua/Utti		Chagunius chagunio
Jaya		Aspidoparia jaya
Joia/Hiralu		Barilius bendelisis
Kabashi		Mystus cavasius
Kachki		Corica soborna
Kai		Anabas testudineus
Kaikka/Kakila	Gar	Xenerntodon cancila
Kaikka		Xenantodon canula
Kajuli		Ailia coila
Kalabata	Carp	Crossocheilus latius
Kali Bans		Labeo calbasu
Kalibaus/Kalia		Labeo calbasu
Kanchan punti		Puntius conchonius
Kani pabda	Catfish	Ompok bimaculatus
Karfu		Cyprinus carpio
Kata		Tachysurus nenga
Katabukha		Batrachocephalus mino
Katari	Minnow/Barb	Salmostoma bacaila
Keti		Rothee cotio
Khailsha	Perch	Colisa fasciatus
Khalisa		Colisa fasciata
Kharu		Pisodonophis boro
Khorsula	Mullet	Rhinomugil corsula
Koi	Perch	Anabas testudineus
Koi Bandi		Badis badis
Koi puti		Anodontostoma chacunda
Koirka	Loach	Nemachilus corica
Koitor		Johnius coitor
Koksa		Barilius vagra
Kossa/Saku		Barilius shacra
Kosuati		Puntius cosuatis
Kuchia	Mud eel	Monopterus cuchia
Kuizza poa		Johnius cujus
Kuli		Eleotris lutea
Kumirer khil		Ichtyocarpus carce
Kursha/Katal		Labeo dero
Kutakanti		Erethistes pussilus
Kutakanti		Hara hara
Lakhua		Polydactylus indicus
Lal chewa		Odontamblyopus rubicundus
Lal Khailsha	Perch	Colisa lalius

Laubuca	Carp	Chela laubuca
Leuzzadarkina		Rasbora rasbora
Lombu	Croaker	Otolithes maculastus
Madhu pabda	Catfish	Ompok pabda
Magur	Catfish	Clarias batrachus
Mahaseer	Carp	Tor putitora
Mohashol	Carp	Tor tor
Mola		Amblypharygodon mola
Mola		Amblypharygodon microlepis
Mola punti		Puntius guganio
Morari		Aspidoparia morar
Mrigal		Cirrhinus mrigola
bailla		Platycephalus indicus
Muri Bacha		Clupisoma murius
Nandina		Labeo nandina
Neftani	Perch	Ctenops nobilis
Neni/Bheda	Perch	Nandus nandus
Nipati		Danio dangila
Nuna bailla		Brachygobius nunus
Nuna tengra		Mystus gulio
Olua	Anchovy	Colia ramcarati
Olua	Anchovy	Colia dussumieri
Panga		Acanthophthalmus pangia
Pangas	Catfish	Pangaius pangasius
Pangash		Pangasina pangasius
Phali		Notopterus noptopterus
Phasa		Setipinna phasa
Phutani punti		Puntius phutunio
Pipla	Snakehead	Channa barca
Poa	Croaker	Pama pama
Poia/Char		Somileptes gongota
Potka	Puffer fish	Chelonodon fluviatilis
Puiya		Lepidocephalus berdmorei
Puiya		Lepidocephalus irrorata
Punti		Puntius sophore
Puti		Puntius spp
Raja chewa		Taenioides buchanani
Rani		Botia dario
Rani/Putul/Beti		Botia lohachata
Rata boura		Moringua rataboura
Rita	Catfish	Rita rita
Rohita		Labeo rohita
Rui		Labeo rohita
Rup chandra	Pomfret	Pampus chinensis
Sada chewa		Trypauchen vagina
Samudra koi		Lobotes surinamensis
Sarpunti		Puntius sarana
Savon Khorka	Loach	Nemachilus savona

Shillong	Catfish	Silonia
Shingi	Catfish	Heteropneustes fossilis
Shoil		Chana Marulias
Shol	Snakehead	Channa striatus
Shor puti		Puntius saviana
Sisor		Sisor rhabdophorus
Tailla		Eleutheronema tetradactylum
Tak chanda		Secutor ruconius
Taki	Snakehead	Channa punctatis
Tapasi		Polynemus paradiseus
Tara baim	Spiny eel	Macrognathus aculeatus
Tara baim		
Tatkeni		
Techoukka/Kanpona	Top-minnow	Aplocheilus panch
Teli phasa		Setipinna taty
Teli/Telchitta		Glyptothorax telchitta
Tengra	Catfish	Batasio tengana
Tengra	Catfish	Batasio batasio
Tengra		Mystus vittalus
Tengra		Mystus vittatus
Tepa/Potka	Puffer fish	Tetraodon cutcutia
Teri punti		Puntius terio
Tila		Barilius tileo
Tit punti		Puntius ticto
Titari		Psilorhynchus sucatio