Government of the People's Republic of Bangladesh
Flood Action Plan

FAP 17

Fisheries Studies and Pilot Project

FINAL REPORT

JULY 1995

EXECUTIVE SUMMARY OF MAIN VOLUME

ODA
Overseas Development Administration, U.K.

FINAL REPORT

EXECUTIVE SUMMARY
OF
MAIN VOLUME

FAP 17
FISHERIES STUDIES
AND PILOT PROJECT

July, 1995

Funded by ODA in conjunction with the Government of Bangladesh

1 Introduction

The Fisheries Studies and Pilot Project (FAP 17) was the only FAP project designed solely to address inland fisheries issues. Phase I, the Fisheries Studies, was a biological and socioeconomic research project which aimed to assess the impact of a range of different types of FCD/I projects on fish resources and on fishing communities dependent to varying degrees on these resources. Phase II, the Pilot Project, was designed to demonstrate feasible strategies to mitigate harmful impacts of FCD/I projects on capture fisheries through the integration of fisheries into water management. Phase I commenced in December 1991 and ended in June 1994. Phase II is presently under consideration by GoB and the ODA.

To assess the impact of flood control on fisheries it was necessary to undertake quantitative investigations of fish production (catch), diversity and movements on floodplains canals and rivers inside and outside FCD/I projects and to examine both quantitatively and qualitatively social and economic factors. Eight FCD/I projects were selected in four FAP regions. The South East Region was not studied. Fisheries and socioeconomic surveys started between August 1992 and February 1993 and ended in February 1994, providing a 13 to 19 month sampling period depending on region.

In the following sections of the executive summary the principal objectives of flood control are briefly outlined and major impacts of flood control on flooding patterns, fish and fishing communities identified by the present study are presented. The identified impacts are then used to provide a basis for the recommendation of a series of fisheries mitigation measures. Finally, a series of topics requiring further research are identified.

2 Objectives of Flood Control

The principal aim of all FCD/I projects studied was to increase rice production. Outside the North East Region, this was to be achieved by the exclusion of external river flooding from protected areas and the conversion of seasonal wetland into drier land on which HYV *t. aman* could replace deepwater rice (*b. aman*). Several other minor shifts in agricultural patterns were anticipated but the main economic benefit of flood control was derived from the predicted increased production of projected HYV *t. aman*, a crop which can tolerate only shallow flooding during the monsoon. Outside the North East Region this is the basic rationale of most flood control projects covering inland low-lying floodplains. In the North

East, two types of FCD/I projects were studied. The first, a partial flood control project using submersible embankments and the second a full flood control project with pumped drainage and irrigation facilities. The aim of all partial flood control projects in this region is to increase winter rice production by reducing damage from early or pre-monsoon river floods. These projects are not designed to alter flooding patterns during the monsoon. The FCD/I project also aimed to increase winter rice production but also anticipated increases during the monsoon season through increased HYV *t. aman* production at the expense of *b. aman*.

3 Impacts on Flooding

Eight flood control projects were selected in four FAP regions (Table 1). The projects were selected to cover a range of different types of flood control which were representative of current developments in Bangladesh. The distribution of projects between regions was rather uneven; three in the North West and one in the North Central Region but this reflected differences in the extent of flood control development between these regions.

The eight projects were divided into three categories based on the degree of flood control achieved during the study period. The three categories are listed below:-

a) **Full Flood Control**: achieved in only one project, the BRE. In the study area and year of study entry of floodwaters from the Jamuna River was highly restricted by a regulator. In other locations in previous years the BRE was repeatedly breached by erosion by the Jamuna. Full flood control resulted in the greatest reductions in magnitude, extent and duration of flooding seen in any of the eight projects studied.

b) **Controlled Flooding**: achieved in three structurally secure full flood control projects. These projects were designed to exclude external river flooding and to convert seasonal wetland into drier land on which to expand the production of HYV *t. aman* at the expense of *b. aman*. In practice, however, farmers chose to operate the projects for the continued production of deepwater *aman* by allowing the controlled entry of external river floodwaters when needed. Intermittent gate opening resulted in a gradual increase in regulated flood levels up to depths of about 3 m reaching a peak in September and thereby avoided rapid seasonal fluctuations in water levels which occurred on unregulated floodplains (Figs 1 and 2). In the PIRDP this resulted in reduced maximum flood levels but in Chalan *Beel* Polder B, increased flooding was

Table 1 Flood control projects studied by FAP 17

Type of flood control	Name of project	Type of project	Performance
Full Flood Control	Brahmaputra Right Embankment (BRE) (NW)	Full river embankment	Successful full flood control embankment in area and year studied. In several other locations the embankment was repeatedly breached by erosion by the Jamuna.
Controlled Flooding	Pabna Irrigation and Rural Development Project (PIRDP) (NW)	FCDI	Structurally secure project designed for full flood control but in which external river waters were allowed entry for the production of deepwater *aman*. This produced controlled deep flooding. Pumped drainage not fully functional up to 1994.
	Chalan *Beel* Polder B (NW)	FCD	Structurally secure project designed for full flood control but in which external river waters were allowed entry for the production of deepwater *aman*. This produced controlled deep flooding.
	Satla-Bagda Project Polder 1 (SBP) (SW)	FCD	Structurally secure project designed for full flood control but in which external canal waters were allowed entry for the production of deepwater rice. This produced controlled deep flooding.
Partial Flood Control	Shanghair *Haor* Project (SHP) (NE)	FCD - with submersible embankments	Structurally secure partial flood control project using submersible embankments to prevent river until May after which floodwaters overspilled. Monsoon flooding unaffected.
	Manu Irrigation Project (MIP) (NE)	FCDI	Full flood control project in which embankments were cut when outside river levels were high resulting in flooding of the project. Pumped drainage and winter gravity-fed irrigation not fully functional.
	Chatla-Fukurhati Project (CFP) (SW)	FCD	Full flood control and drainage project in which external river flooding occurred due to non-functioning regulators and damaged embankments.
	Compartmentalization Pilot Project (CPP) in Tangail (NC)	FCD	Flood control and drainage project which did not prevent river flooding due to poor design of original project (Silimpur-Karatia) and non-completion of current design (CPP).

recorded as water was conserved for the deepwater *aman* inside the polder as external rivers levels dropped temporarily during the monsoon.

Figure 1 Comparison of water levels inside and outside Koitala and Talimnagar regulators in the PIRDP, May - December, 1993

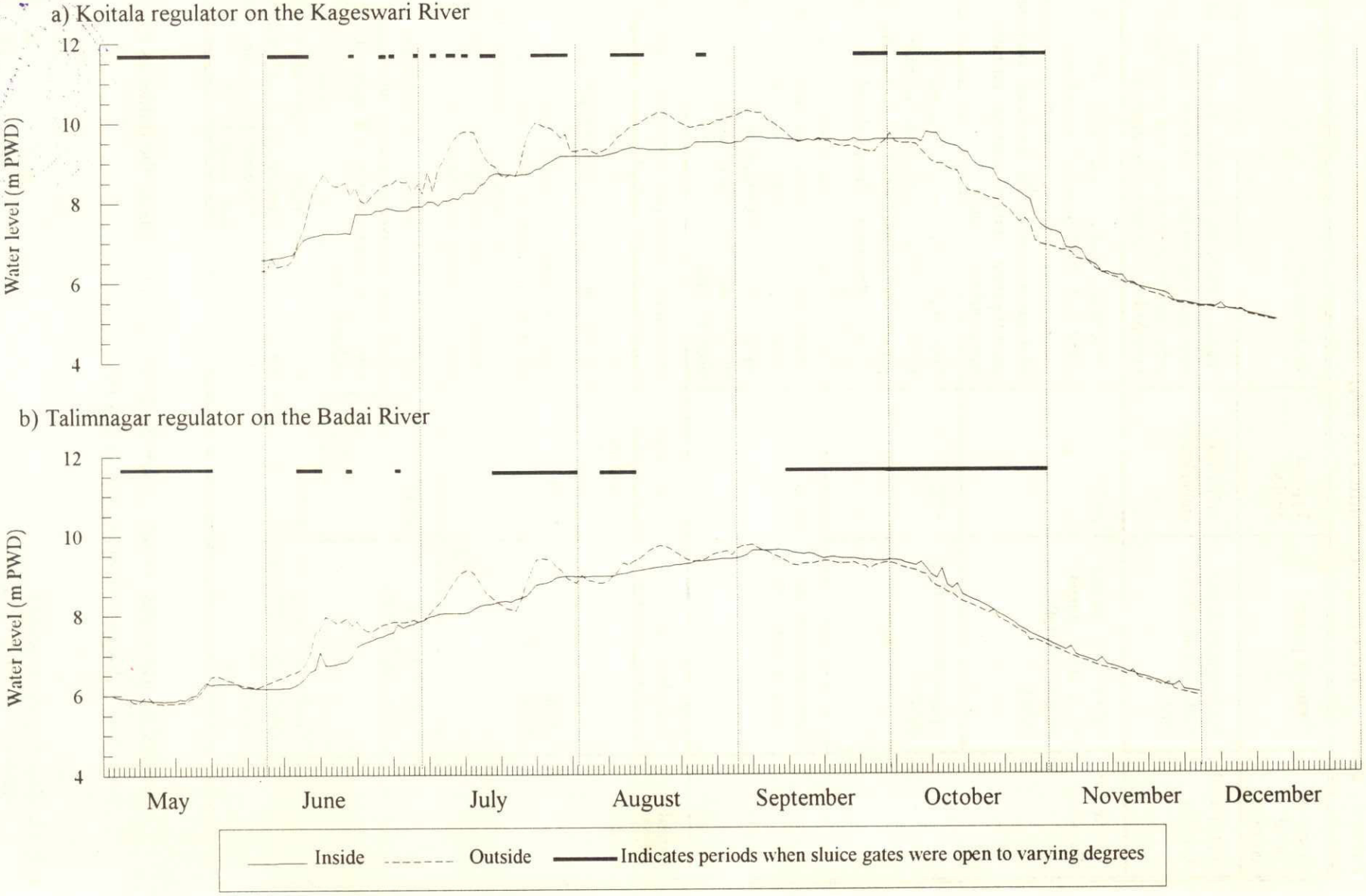
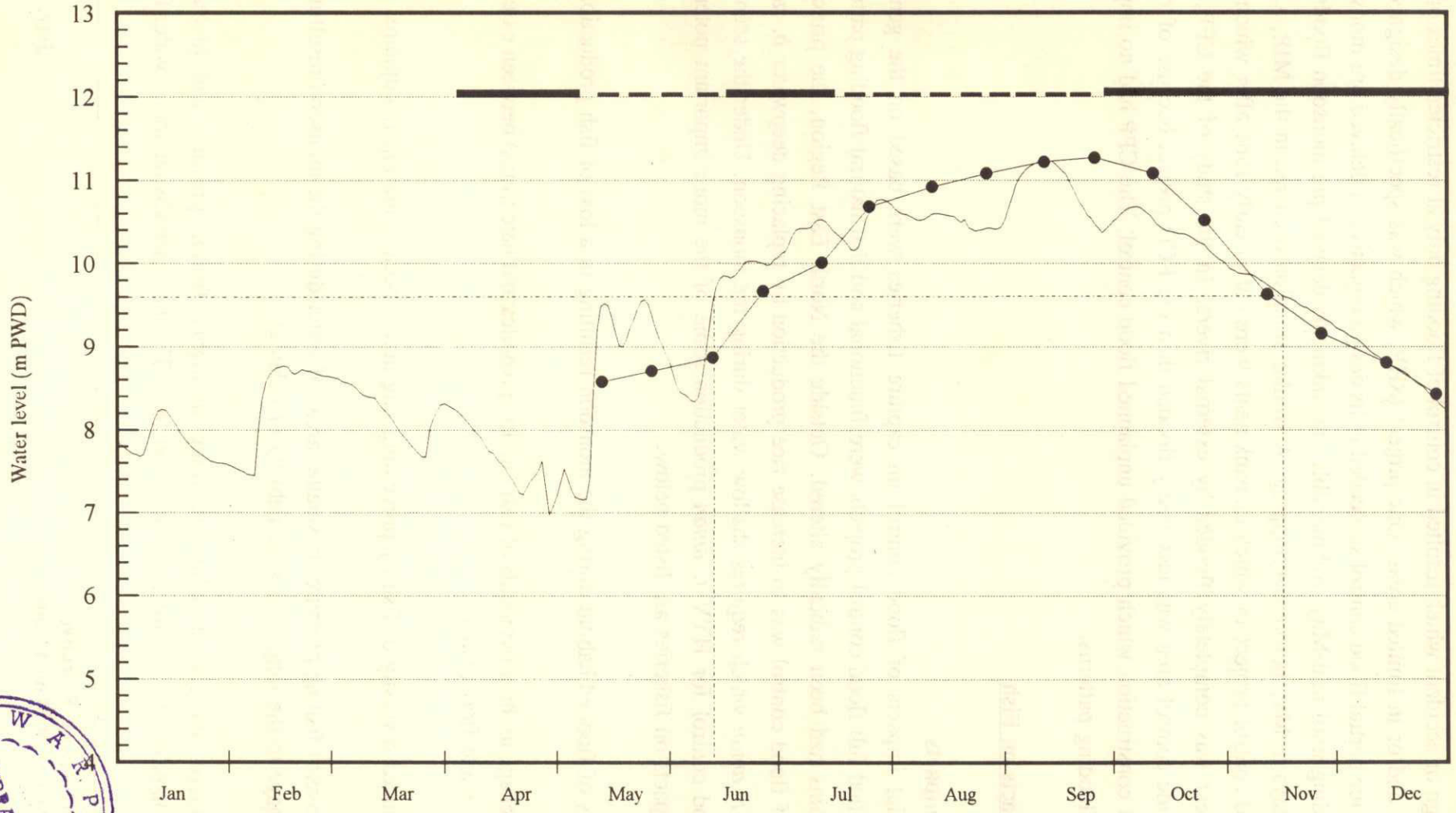


Figure 2 Comparison of water levels in Haribhanga *Beel* and the unregulated Chalan *Beel*, January 1993 - December 1993



Notes:
1. ——— Denotes water level in Atrai River and on the unregulated Chalan *Beel* between June and November
2. —●— Denotes water level in Polder B
3. ····· Denotes level and date at which Atrai River flooded the unregulated Chalan *Beel*
4. ▬ – – Solid and dashed lines denote sluice gates open and closed respectively

c) **Partial Flood Control**: achieved by a range of different types of project either by design or accident which resulted in control of flooding only at restricted times of the year and/or in limited areas. One project (SHP) which was specifically designed to provide partial flood control succeeded in its design objective of delayed pre-monsoon flooding until mid-May. Submersible embankments delayed pre-monsoon floods by 19 days in May before overtopping. A similar situation occurred in the MIP, a full flood control project in which embankments were cut in early June after which the project was completely flooded by external rivers. In the study of the CFP, the outside control area was less freely flooded than the FCD project because of rural road construction which provided unplanned flood control. The CPP had no impact on flooding patterns.

4 Impacts on Fish

Potential impacts

The potential impacts of flood control on capture fisheries were based on the general perception that full flood control projects were functional and that natural flooding patterns on floodplains had been radically altered. Outside the North East Region, the principal objective of flood control was to increase rice production by replacing deepwater *b. aman* with HYV *t. aman* which requires shallow water during the monsoon. Under the scenario of full flood control for HYV *t. aman* production some of the more important potential adverse impacts on fisheries are listed below.

i) Loss of flooded habitat during the monsoon resulting in a loss of fish production.

ii) Blockage to the movements of fish (adults, juveniles and hatchlings) between external rivers and floodplains.

iii) Reduced diversity of fish by preventing migratory species entering floodplains.

iv) Increased fishing pressure on smaller areas of water during the monsoon resulting in damage to the long-term sustainability of fisheries.

v) Reduced dry season habitat resulting in higher fishing pressure and increased catchability of overwintering fish broodstock. The increased abstraction of water from

beel to irrigate surrounding rice fields was of particular concern.

vi) Reduced groundwater recharge resulting in a lower water table in the dry season which in turn could lead to a reduction in the area of perennial *beel*. Dry season rice production dependent on tubewell irrigation was also thought to be at risk from lowered groundwater levels as well as increasing the problems for drinking water supplies.

vii) Loss of high value migratory species such as major carps and catfish by preventing migrations between rivers and floodplains and thereby interfering with their life cycles.

viii) Increased fish disease by the creation of adverse environmental conditions such as stagnation of standing waters which could trigger disease outbreaks in already stressed and modified fish communities.

Identified impacts

Those impacts of flood control on fisheries which were identified by the FAP 17 study are summarised below.

Loss of catch through loss of habitat

Whenever flood control projects reduce the area of flooded land there will be a loss of habitat for fish production. The results from unregulated floodplains, *beel* and canals outside eight flood control projects in four FAP regions showed that the annual fish yield or catch per unit area from this lost habitat varied geographically between regions and between different land heights. The yields given here refer to land heights within the flood phase series F2-F4 and ranged from 68 kg/ha to 202 kg/ha with an arithmetic mean value of 119 kg/ha.

Reduction in catch per unit area (CPUA)

Prior to the FAP 17 study, the general perception in Bangladesh was that FCD/I development had reduced fish catches through loss of habitat and reduced catch per unit area from the remaining regulated floodplains. The FAP 17 results revealed, however, a more complex relationship between catch, the degree of flood control, fish densities and the amount of fishing effort. Under full flood control annual CPUA was reduced by 81%; under controlled

flooding for deepwater rice catches increased in two projects due to higher fishing effort, and was reduced in a third by 37%. Under partial flood control CPUA values were similar inside and outside three projects but were reduced in a fourth by 20% because of restricted entry of fish.

Reduced fish density/abundance

Of the four projects providing full flood control or controlled flooding, statistical analyses revealed that fish densities were significantly lower in two of them. In two projects which provided only partial flood control no significance differences in fish densities inside and outside embankments were detected. In a third, the MIP, significantly lower densities were found prior to cuts in embankments and significantly higher densities later in the year following several cuts which allowed fish through the embankments. It is concluded from these results that flood control can result in a significant reduction in biological productivity by decreasing fish abundance even when sluice gates provide restricted access to floodplains.

Increased fishing effort

Under full flood control, lower flooding substantially reduced the opportunities for fishing and the amount of fishing effort per unit area of floodplain compared with that on unregulated floodplains. In contrast, controlled river flooding provided more stable and predictable hydrological conditions which stimulated increased fishing effort by small-scale subsistence gears along village shorelines. This increase in fishing effort resulted in higher catches from regulated floodplains than on unregulated areas. In three projects providing partial flood control, fishing effort was again higher than outside. Increased effort invariably stemmed from the greater use of subsistence gears near homesteads. It is not known at present what effect such increased fishing pressure has on the long-term sustainability of fish stocks.

Reduced biodiversity

Full flood control and controlled flooding had an adverse impact on fish diversity. The effect of full flood control was more severe and resulted in a reduction of 33% in the total number of species recorded annually. Projects which used controlled flooding in the North West Region reduced diversities by 19% to 25% while in the South West Region diversity was less affected (4% reduction) but this was due more to the relatively low diversity of migratory fish on both regulated and unregulated floodplains. Partial flood control had little adverse impact on biodiversity. Comparisons of different fish groups showed that there were greater

reductions in diversities of migratory species than floodplain residents. Reductions of 95% and 29-45% were found for migratory species under full flood control and controlled flooding. These results demonstrate clearly the mitigating effect on species diversity of controlled flooding for deepwater rice compared with the impact of full flood control for HYV *t. aman*.

Reduction in migratory fish

The contribution to catches by migratory species was substantially reduced by full flood control and controlled flooding but relatively unaffected by partial flood control except in the MIP where a reduction on regulated floodplains of 19% was found despite cuts in embankments. The results showed that as the degree of flood control increased, catches of migratory species which included large, high-value species such as major carps and catfish, decreased.

Disruption of fish community structure

Results from analyses of catch compositions revealed that fish community structure in flood controlled areas was disrupted not only by a loss of riverine and migratory species but also by major changes in the composition of the remaining floodplain resident species. As the degree of flood control increased there was a corresponding loss in community heterogeneity and catches were increasingly dependent on a relatively small number of abundant floodplain resident species. Under these conditions there is a danger that the capability of fish stocks to sustain increased fishing pressure may be impaired and that disease outbreaks may be more frequent and damaging. At present it is not known how serious these potential problems may be.

Reduced fish migrations

Full flood control and controlled flooding reduced lateral fish migrations between rivers and floodplains in two ways; firstly, by reducing the number of entry points on to floodplains and thereby concentrating fish into fewer channels where they were more susceptible to capture, and secondly, by closing gates of regulators for extended periods during the pre-monsoon and monsoon. Controlled flooding did, however, offer greater opportunity for fish to enter floodplains than under full flood control since gates were opened intermittently to allow the entry of river waters for the cultivation of deepwater *aman*. Gate closures also blocked the entry of fish hatchlings carried downstream in rivers by passive drift and prevented them reaching nursery areas on floodplains. Even when gates were open, severe hydraulic

conditions reduced densities and supply rates in regulated rivers. Submersible embankments used for partial flood control in the North East Region delayed entry of hatchlings and juvenile fish such as *rui*, *kalbaus* and *chapila*.

Increased capture at regulators

Several examples were seen across all types of flood control in which regulatory structures on rivers and canals were deliberately used to prevent or hinder the passage of fish and facilitate their capture. In other cases, structures by their very presence acted as obstacles to passage, for example the Charghat regulator on the Baral River in North West Region, provided the opportunity for the establishment of specialist fishing techniques to operate from the walls of the structure as fish were slowed or blocked during attempts to migrate upstream through open gates to the Padma River. On other rivers, regulator gates were opened for short intervals to allow the capture of incoming fish immediately downstream.

Reduced opportunity for mitigation measures

Exclusion of external river waters under full flood control for the increased cultivation of HYV *t. aman* substantially reduces the options available to mitigate against adverse impacts of fisheries compared with those available under controlled flooding for deepwater *aman*.

Reduced potential for stock enhancement

Whenever flood control results in a reduction in the extent and magnitude of flooding, the area available for potential stock enhancement by stocking floodplains with fish, is reduced. The severity of this impact is related directly to the degree of flood control exerted by the project and the topography of regulated floodplains. Under full flood control there would be little opportunity for extensive stocking of open-water floodplains.

5 Impacts on People

The project which provided the highest degree of flood control, the BRE, was not covered by socioeconomic surveys and therefore the greatest social and economic impacts of flood control probably were not recorded. This also partly explains why it was not possible to identify quantitatively impacts solely caused by flood control since in all projects studied, there were substantial monsoon floods. The FAP 17 social and economic surveys did however provide quantitative descriptions of rural communities and their varying levels of economic dependence on capture fisheries which are summarised briefly below.

1. The incomes of households in fishing communities were highly dependent on the fisheries resource - across all regions, those households showed between 50% and 90% dependence on activities related to fishing.

2. In the North West and South West regions, small and landless farmers in agricultural communities were significantly dependent on fisheries. In those areas, between 9 and 15% of these farmers' incomes were generated from fisheries.

3. In all areas except the North East, fisheries accounted for significant portions of the incomes of the landless during the flood season. Between 10 and 25% of landless farmers' incomes in those areas was derived from fisheries during the flood season.

4. In agricultural communities in all regions, there were high levels of participation in fishing even by those groups which reported low-levels of dependence on fishing for their income. In North Central, North East and South West areas over 60% of all categories of farmers reported some participation in fishing.

From the results of social and economic studies it was then possible to identify several potential impacts of flood control which are listed below.

1. Whenever full flood control effectively reduces the magnitude, extent and duration of flooding resulting in a decrease in fish production, all groups dependent on the fishery will lose income, a cheap source of animal protein and employment opportunities. The adverse impacts will affect subsistence, seasonal and professional fishermen, and also leaseholder and fish traders.

2. Under controlled flooding for deepwater *aman*, professional fishermen may lose income through a reduction in the extent of public water bodies which they traditionally fished and through increased competition from agricultural communities.

3. Under controlled flooding for deepwater *aman*, subsistence and seasonal fishermen can gain through increased fishing opportunity so long as they have access to waters.

4. Where flood control allows greater control of drainage, fisheries leaseholders may make short-term gains through increased catches when *beel* and *khal* are drained

almost completely by sluice gates or when sluice gates are closed temporarily to trap fish and increase their ease of capture. In the longer-term, however, these practices may be very damaging to the sustainability of fisheries.

6 Recommended Mitigation Measures

A clear distinction was drawn between compensation and mitigation strategies. Compensation measures rely on aquaculture and culture-based techniques to increase fish production and thereby compensate, to varying degrees, for the lost tonnage of fish due to flood control. In contrast, mitigation measures are designed to reduce or avoid losses to capture fisheries. Recommendations have focused solely on mitigation measures since these are considered to provide greater and more extensive potential increases in catch which can be shared more equitably between different fishing groups within rural communities.

Production of deepwater aman and capture fisheries

This mitigation measure questions a principal rationale of flood control: to convert low-lying seasonal wetlands to drier land where deepwater *aman* can be replaced by HYV *t. aman*. The numerous harmful impacts on capture fisheries caused by full flood control for the cultivation of HYV *t. aman* have been detailed in section 3.6 of Main Vol. Contrary to the expectations of planners of full flood control projects, farmers in projects which were structurally secure and operationally functional, preferred to operate sluice gates to provide controlled flooding by external rivers for the continued production of deepwater rice rather than attempt to convert to HYV *t. aman* on lowlands prone to rainfall flooding.

This is the most effective mitigation measure to reduce losses to capture fisheries caused by full flood control and one which has spread through rural communities as a result of farmers' needs and preference. The measure is applicable to all lowland floodplains (F2-F3 flood phase categories) where local rainfall flooding cannot be drained by gravity because of high river levels. These areas cover most of those targeted by the Flood Action Plan, outside the North East Region.

Habitat rehabilitation and protection

This measure is designed to reduce the negative impact of flood control on fish production caused by loss of winter and pre-monsoon habitats. Important dry season habitats such as perennial *beel* and *baor* in which the magnitude, extent and duration of flooding have been

severely reduced by flood control, should be rehabilitated by reconnection to original feeder river systems and maintenance of adequate dry season water levels. It is anticipated that canal re-excavation work will be needed inside and outside flood control embankments together with modifications to sluice gate operations. This measure is applicable in higher land areas of full flood control and controlled flooding where strategic connections to external rivers can be made via canal systems leading to *beel* or *baor* without causing extensive flooding of surrounding agricultural land. It has considerable potential value in the North West Region in flood protected areas behind the Brahmaputra Right Embankment, in the PIRDP and in areas to the west along the Padma River. It also has potential in areas of the North Central Region where natural siltation has resulted in impacts on fisheries similar to those caused by flood control.

Increased fish migration across flood control structures

This measure is designed to increase fish production by increasing movements of fish and fry between rivers and floodplains. It requires no change to the design of structures but relies upon a modification to the operating schedule of sluice gates. Under full flood control there is little opportunity to introduce this measure as a realistic means of increasing fish recruitment on to floodplains because of the incompatibility of flood level requirements of HYV *t. aman*. In contrast, the measure offers considerable potential under controlled flooding for deepwater rice where small adjustments in gate operations at critical periods between June and July would allow the entry of major carp hatchlings at times when their densities and supply rates are at a maximum. It is anticipated that this measure would also result in increased species diversity as more migratory adult and juvenile fish would be able to reach floodplains together with hatchlings brought in by passive downstream drift. The measure is applicable to all floodplains which can support deepwater rice under natural and controlled flooding regimes and to the deeper *beel* areas associated with these floodplains.

A related mitigation measure has been established recently in the North East Region where a fish pass has been installed in the MIP to allow the passage of fish from floodplains to river against high water level differences during the pre-monsoon and early monsoon. The measure may have wider application on the Jamuna and Padma rivers where structures on regulated distributary rivers were shown by FAP 17 to block the upstream movement of many migratory fish.

Fisheries conservation: beel management

This measure is designed to increase the survival of fish broodstock during the dry season, a critical period in their life, when they are vulnerable to over-fishing in flood controlled areas. Increased survival of broodstock should result in a greater recruitment of juveniles into the following year's fishery which in turn should lead to increased fish productivity. The measure has national applicability and can be undertaken on a range of different types and sizes of perennial water bodies. It will involve the control of dry season *beel* and their conversion to temporary fish sanctuaries during the winter. This can be achieved most easily by the installation of large *katha* which prevent most opportunistic fishing methods and provide shelter for fish. On a smaller scale, the same approach can be adopted using artificial water bodies, *kua*, on floodplains particularly in the South West Region where they are very common. This measure should protect a large number of different fish species and therefore benefits to the fishery will be spread across a broad spectrum of fishing groups within the rural community.

Fisheries conservation: prohibited fishing zones on regulators

Flood control structures which block or delay movements of fish in rivers or canals thereby increasing their susceptibility to capture should be classified as prohibited fishing zones. Fishing from the structure itself and from a set distance upstream or downstream from it should be made illegal. Distances will vary depending on the size and location of the structure and the size and nature of the regulated water course.

Fisheries conservation: protection of river (duar) fisheries

Studies carried out by FAP 17 and FAP 6 have demonstrated the great importance of river *duar* (scour holes) as winter refuges for large species of fish, particularly catfish and major carps. *Duar* are presently included in riverine *jalmahal* where they are intensively fished by leaseholders during the dry season. FAP 6 has recommended prohibition of fishing *duar* during the dry season and the establishment of river patrols by DoF to enforce protective fisheries regulations. FAP 17 results support this measure as a means of conserving important overwintering broodstock of high value species which form the basis of both riverine and floodplain fisheries. This measure has particular relevance to the North East Region.

Conversion of full flood control to partial control

In areas such as the Manu Irrigation Project in the North East Region, full flood control and river confinement by embankments have resulted in higher flooding levels and increased

frequency of damaging floods. Local people have responded by cutting embankments to reduce flooding of their homesteads. A similar situation was seen in Chalan *Beel* in the North West Region. In that area FAP 2 recommended converting full flood control projects to partial flood control to reduce flood levels and increase deepwater *aman* and fish production. This is also the recommendation made by FAP 17 for similar situations in the North East Region and specifically for the MIP.

Provision of flood pathways in extensive areas protected by submersible embankments
Examination of the impact on fisheries of a single partial flood control project in the North East Region revealed little cause for concern. However, the wider, cumulative effects of extensive contiguous developments were not investigated but FAP 6 expressed concern about the possibility of increasing flood levels in rivers due to channel confinement and sediment deposition. As a possible solution to this problem FAP 6 suggested that certain *haor* remain unregulated to reduce flood levels at critical points in rivers and allow wider deposition of silt loads. The option would benefit capture fisheries so long as siltation did not threaten the long-term survival of *beel* and thus overwintering fish broodstock. It is therefore recommended as a mitigation measure in those areas of the North East Region where extensive partial flood control developments exist or are planned.

Increased fish migration across rural roads
Unplanned rural road development, often supported by the Food for Work Programme, have resulted in blockage to floodwaters and fish on floodplains. The adverse impact of rural road construction was seen clearly in one study in the South West Region in which fisheries outside formal flood control areas were less abundant and diverse than in areas of partial flood control. To reduce the adverse impacts of rural road construction there is a need for institutional changes in the inter-sectoral planning process and a practical change to ensure greater provision of culverts through roads wherever they cross existing canals or traverse extensive areas of open floodplain. Although this problem was identified clearly in the South West Region, the mitigation measure has national relevance to fisheries.

Strengthening of technical assessment and planning capabilities of BWDB/WARPO
There is a need to establish within BWDB/WARPO a multidisciplinary technical assessment unit comprising expertise from fisheries, agriculture, environment, hydrology and hydraulic engineering. The unit should be responsible for the re-evaluation of operating procedures of existing structures and for the examination of future flood control projects. Proposals for

major new road or rail links should also be assessed by the unit in terms of their impact on flooding patterns, fisheries and agriculture. The eventual siting of the assessment unit would depend on the future roles of BWDB and WARPO.

Establishment of national database on FCD/I projects

A detailed and comprehensive national database should be established by BWDB to provide information on all flood control projects in Bangladesh and the major regulatory structures within these projects. The database should provide a basic description of the design and size of each structure, its function within the project area and its state of repair. Daily water level data at each structure should also be provided with computed head differences. The database should be made available, in a user-friendly form, to other government agencies.

Improvement of data collection by BWDB

There is an urgent need to improve the quality of data collection by BWDB personnel responsible for the operation of regulatory structures. Supervisory personnel should ensure that accurate detailed daily records are maintained of water levels at the structure (inside and outside), numbers of gates open and height to which each gate is opened. These data should be incorporated into the national database at monthly intervals.

Establishment of water-user groups

Local groups of water users should be established in flood control projects to represent the full range of sectors affected by modified flooding patterns. This should include capture fisheries as a water-user group. Representatives from each group should form a local committee in association with relevant government departments to establish operating procedures of regulatory structures. The committee would provide the mechanism for the establishment of local integrated water management.

Training within BWDB

An annual series of training courses should be established within BWDB to give engineers a basic understanding of the water requirements within each natural resource sector, focusing on fisheries and agriculture. The fisheries course should contain descriptions of identified adverse impacts of flood control on fish and various methods of mitigation against such impacts.

Development of flood modelling techniques

There is a need to continue the development of flood modelling techniques using the MIKE11 hydrodynamic model. The SWMC and FAP 19 are currently active in this field but require future support, both financial and technical, to continue to make progress. The work would require detailed field surveys to improve basic topographical information.

7. Future Research Requirements

FAP 17 investigations provided quantitative baseline data on several aspects of freshwater fisheries in various regions of Bangladesh. Because of the widespread nature of sampling effort and the relative short duration of field data collection (12-19 months), it was not possible to obtain a detailed understanding of the ecology, biology or population dynamics of even the few most important floodplain fish in relation to changes in flooding patterns. It is therefore important to use the baseline data of FAP 17 as a foundation for further longer term fisheries studies which should provide both greater detail and scope of research activities.

A series of mitigation measures has been recommended for implementation in the short or near term. This needs to be strengthened by further research, some basic, but most adaptive. Areas requiring more research work were identified during studies on each of eight flood control projects and in three ancillary supporting studies. Most of these have been documented previously in the supporting volumes of fisheries studies. From these studies a more generalised list of research topics has been compiled and is listed below.

1. Quantitative catch assessment surveys to obtain estimates of fish densities and yield per unit area of floodplain. These data, when collected over a long-term period of up to five years on representative floodplains and linked with a concomitant set of quantitative data on flooding patterns, will provide the first rational basis for the development of a floodplain fisheries model. This can then be used as a predictive tool to provide future advice on fisheries management and development.

2. Stock assessment using length frequency analysis and ageing techniques to obtain information on the population dynamics of selected species of fish and prawns dominating floodplain catches. This study will provide information on growth, mortality and the status of stocks and allow predictions to be made of the effects on

20

fisheries of further increases in fishing pressure. This study is particularly relevant to flood controlled areas where higher levels of fishing effort have been recorded on fish communities in which diversity has been reduced and a greater dependence placed on a small number of floodplain resident species. The current status of the stocks of these species is not known.

3. Investigation of the biology and ecology of selected fish and prawn species dominating floodplain catches inside and outside FCD areas. Information collected should include data on age, breeding biology, feeding habits and micro-distributions in relation to seasonal changes in flooding and the distribution of aquatic vegetation including deepwater rice. The study should also include detailed limnological investigations which examine plankton, macroinvertebrates and water quality, particularly nutrient levels. The role of deepwater rice fields in providing shelter from certain fishing gears and natural predators in addition to providing food, should also be explored in detail. This study will provide an understanding of the overall functioning of the dominant fish and prawn community in relation to open-water habitats and deepwater rice fields.

4. Assessment of the impact of FCD projects on the diversity of fish and prawns. Standardised systematic, intensive sampling is required to record not only the more common species but also the numerous rarer species which may be more vulnerable to adverse impacts of flood control.

5. A national capability to provide systematic quantitative information on geographical variations in diversity of aquatic resources of Bangladesh should be established. This measure is designed to improve the basic knowledge of the diversity of fish, shrimp and prawns and to identify environmental problems, including flood control, linked with reductions in biodiversity. This information can then be considered at the project identification and planning stage of future developments which impact on aquatic resources. The measure should involve the strengthening of institutions such as DoF and FRI through training in a) fish taxonomics b) procedures for the establishment of fish reference collections c) methods for planning and implementing field surveys and sample collections and d) data analysis. It is anticipated that there would be a need to assist institutions in the design and implementation of national field surveys and sample collections.

6. Investigation of the movements of fish and prawns between rivers and floodplains which are free-flooding and others on which flooding is controlled. This study will require continuous daily monitoring of catches in canals linking rivers with floodplains. Tagging studies may also be employed if preliminary studies indicate that the method provides useful information.

7. Investigation of movements by passive downstream drift of fish and prawn hatchlings between rivers and floodplains in relation to seasonal changes in river discharge. This study is essential on the BRE where the Jamuna River provides an annual supply of hatchlings of major carps and many other species of fish.

8. Investigation of the impact of water regulators on the survival and movement by passive downstream drift of fish and prawn larvae in relation to seasonal changes in river discharge. This study has particular relevance on the Brahmaputra/Jamuna and Padma rivers.

9. Determination of water velocities from a range of different types of structures operating under varying head differences and gate openings. These data should be collected by BWDB and incorporated into a national database on water regulators.

10. Determination of swimming speeds of selected fish species. This work requires carefully controlled laboratory flume studies and therefore the most appropriate approach may be a joint study between the Fisheries Research Institute (FRI) and the River Research Institute. Results from this study would be related to data on water velocities at regulators to provide quantitative management advice on the operation of various types of regulator.

11. Integration of biological information derived from research studies (numbers 6-10) and flood modelling techniques to improve the predictive capability of impact assessments of flood control projects and assist in the design of future water regulator structures. This work requires institutional collaboration between fisheries research organisations and hydrodynamic modelling specialists such as the SWMC, Dhaka.

12. Identification of possible spawning grounds of major carps in the Brahmaputra and Padma rivers in Bangladesh and investigation of upstream breeding migrations in these rivers.

22

13. Investigation of the migrations of fish along rivers of the North Central Region to identify possible environmental factors which might explain the general scarcity of riverine and migratory species compared to some other regions in Bangladesh.