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FAP-12

Government of the People's Republic of Bangladesh

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

BANGLADESH FLOOD ACTION PLAN

FAP 12
FCD/I AGRICULTURAL STUDY

15

RAPID RURAL APPRAISAL OF KATAKHALI KHAL PROJECT

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BN-394
A-492(1)

December 1991

Hunting Technical Services Limited

in association with:
Bangladesh Institute of Development Studies
Flood Hazard Research Centre
Hunting Fish-Tech
Technoconsult International Limited

under assignment to
UNITED KINGDOM OVERSEAS DEVELOPMENT ADMINISTRATION

Sanyu Consultants Inc.

under assignment to
JAPAN INTERNATIONAL CO-OPERATION AGENCY

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The present report is one of a series being produced by Flood Action Plan components 12, the FCD/I Agricultural Study and 13, the Operation and Maintenance Study.

The full series is expected to comprise the following reports:

FAP 12

Inception Report (joint with FAP 13)
Methodology Report (2 Volumes)
Rapid Rural Appraisals Overview

Project Impact Evaluation studies of:

*Chalan Beel Polder D
*Kurigram South
*Meghna Dhonagoda Irrigation Project
*Zilkar Haor
*Kolabashukhali Project

Rapid Rural Appraisal Studies of:

Protappur Irrigation Project
Nagor River Project
Sonamukhi Banmander Beel Drainage Project
Improvement of Sakunia Beel
Silimpur - Karatia Bridge cum Regulators
Katakhali Khal
Halir Haor
Kahua Muhuri Embankment
Konapara Embankment
Polder 17/2
BRE Kamarjani Reach
BRE Kazipur Reach

* Draft Final Report (2 Volumes)
* Final Report (2 Volumes)

FAP 13

Methodology Report
Appraisal of Operation and Maintenance in FCD/I Projects (2 volumes)
Draft Final Report
* Final Report

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1 . Revised versions of these RRA reports issued December 1991.

Project Summary Sheet

Project Name	: Construction of bridge-cum-regulator at Katakhali Khal
Project Type	: Flood Control and Drainage
Location	
FAP Region	: North-Central
District	: Jamalpur
Area (ha.)	: gross: 2660 ha. (project appraisal), 3000 ha. (post-evaluation) net cultivable: 2226 ha. (project appraisal), 2520 ha. (post-evaluation)
Funding Agency	: EIP (Netherlands and Sweden)
Implementing Agency	: BWDB
Construction started	: 1980-81
Scheduled Completion	: 1981
Actual Completion	: 1982-83
Original Cost Estimate	: Tk 8.36 million (1983 financial prices)
Final Cost Estimate	: Tk 9.5 million (1983 financial prices)
Major Flood Damage:	: 1988
Repair/rehabilitation in	: none to date

SUMMARY OF FINDINGS

Project Background

Katakhali Khal Project is located in Sarishabari Upazila of Jamalpur District and Modhupur Upazila of Tangail District, about 40 km. south of Jamalpur in the FAP north-central region. The boundary of the Project to the west is the embankment along the Jhinai river, but elsewhere the boundary of the impacted area is unclear. The Project has had some effect on a wider area than had been claimed and probably benefits about 2520 cultivable ha. (gross area 3000 ha.).

Project Objectives

The Project aimed to benefit Aus and Aman cultivation by reducing monsoon water levels by 1.5 m. in a 1-in-5 year flood (on the Jhinai river), and by reducing the rate of rise of flood water. This was expected to result in an increase in the area of T Aman at the expense of B Aman, and to an increase in average annual yields. These aims were to be achieved by constructing an embankment along the Jhinai river with regulators and sluices to prevent river water flowing up the drainage khals but to permit drainage at other times. The standard of flood protection was up to a 1-in-20 year flood.

Engineering Assessment

The Project was taken up under EIP, designed by BWDB, and implemented by BWDB. Although intended to be completed within one season (1980-81), work was not completed until 1982-83. During implementation the Project was substantially modified, although there are no documents to justify this. Only 7.25 out of a planned 14 km. of embankment were built, the remainder of the effective embankment being a strengthened village road (a rare example of integrating FCD infrastructure with local roads, and so reducing land acquisition). Additionally the capacity of the main regulator was reduced, and an extra box sluice was built, the project thus comprising two regulators, three box sluices and two pipe inlets.

The structures appear to have been well built, but poor planning means that part of the Project area is cut off from natural drainage by the embankment and earth roads, resulting in public cuts when local rainfall is heavy.

Operation and Maintenance

Poor maintenance now threatens the effectiveness of the structures: the surrounding embankments are deteriorating, and two regulator gates are in a poor state of repair. Drainage provisions are inadequate - there appears to have been no khal re-excavation. Additionally there are three breaches in the embankment dating from 1988 when weak points failed in an exceptional flood. These breaches had not been repaired by 1991 and so the effective standard of protection is much reduced.

There are no khalashis for the structures, but local committees have been established for the main regulators. The committees are dominated by local influential persons, while the box sluices serve small areas and effectively are privately operated. There is no formal public participation in maintenance, and only the earth road is maintained, there having been no resectioning of the embankment since completion. However, local people were mobilised to

raise part of the embankment in 1988. Unfortunately the embankment breached and overtopped upstream.

Agricultural Impact

Despite problems of drainage congestion, the Project has resulted in reduced monsoon water levels on most land levels, although the duration of flooding is little different in some areas. As a result there have been substantial changes towards growing higher yielding Aman varieties: B Aman has disappeared, and short stemmed HYV Aman has been introduced on 49 per cent of the Aman area. These changes can be attributed to the Project, but over the same period HYV Boro has come to dominate winter cultivation (86 per cent of cultivable land), while Aus and jute cultivation have declined. It is unlikely that the Project has encouraged Boro cultivation which has also expanded in adjacent areas and which is not protected from early floods in this area. However, the drying up of beels may have been accelerated by the Project. Overall paddy production has trebled, but the monsoon season gain from the Project has been about a 50 per cent increase in paddy output.

Livestock Impact

Livestock impacts have been mixed. The expansion of Boro cultivation and reduction in Aman crop failures from flood damage have reduced the area of grazing with a consequent decline in the cattle population, which has not been counteracted by the increased production of paddy byproducts. However, the increased availability of bran does appear to have encouraged growth of poultry raising.

Fisheries Impacts

The Project area contained a small but locally important capture fishery based on seven beels in the Project area. This has been all but destroyed. The decline in the area of beels might have happened to some extent without the Project, but the embankment and structures have prevented movement of fish between the rivers and beels and floodplain. Consequently it is estimated that at least 80 per cent of open water fish production has been lost in the Project area. There has been a major increase in pond fish cultivation with new ponds being constructed, but this represents only a small fraction of the lost production. It is likely that the Project has also reduced fish production in adjacent rivers, whose stock depended on the nearby beels and floodplain. However, this loss is difficult to quantify and may not be linked with any one project. There is some sign that stocking of the beels is partly compensating for the loss, but this will need further work to be effective.

Infrastructure and Flood Losses

There has been some development of local road transport, but this would probably have happened in any case as part of the embankment is also a local road. The embankment has provided a sense of security from flooding, but this may be unwarranted as the Project could not prevent widespread flooding in the area in 1988 when about 35 per cent of houses collapsed. Since similar damages would have occurred without the Project, it is unlikely that it has brought much benefit from non-agricultural flood protection. Even crops are not immune from flood damage, although the frequency of damage is clearly reduced.

Socio-Economic Impacts

Associated with the general increase in paddy production (part of which is due to the Project) there has been a rapid growth in rice milling and in trade in paddy, turning the area from a deficit to a surplus grain producer. Employment has thus increased both in agriculture and in secondary activities, but the increase is relatively small and has not prevented the incidence of out-migration for work increasing since the Project.

The Project is likely to have widened the income differential between larger landowners (the main beneficiaries) and the landless. However, it does provide some security from flooding and damage to property for all categories of households. Fishermen have been a particularly disadvantaged group. Many of the previous fishermen have changed occupation or moved away and the real incomes of those who remain have declined since the Project. Associated with the reduced fish availability is a reported absence of a major improvement in nutritional status for most households.

The Project's impact on women does not appear to have been great, but is positive: there is more work available in post-harvest activities, poultry rearing has been encouraged, and vegetable production is reported to have increased (possibly reflecting the loss of rabi crops).

Environmental Evaluation

The Project has had a substantial positive impact on crop production, but has had a proportionately greater adverse impact on fisheries. Underlying these impacts are some important changes in the physical and biological environment. The area of wetlands in the Project area has been substantially reduced in favour of cultivation. This change extends over a wider area than the original Project definition and reflects a mixture of natural drying out of beels and accelerated local siltation, which may be because flood water does not carry sediment out of the Project. Surface water quality appears to have declined without the cleansing effect of floods. The loss of wetlands has reduced the biological diversity of the area. In particular the fish community has been severely reduced. There do not appear to have been any important physical impacts of the Project on areas outside the embankment.

Economic Post-appraisal

Despite cost overruns the cost of the Project was relatively modest at about Tk 7500 per net cultivated ha. (1991 financial prices) or Tk 4200 per net cultivated ha. (1991 economic prices). The annual agricultural benefits to Aman cultivation are about three times the disbenefit to fisheries inside the Project (any impact on fish production outside the Project could not be quantified). As a result, even allowing for the continued risk of crop damages from flooding because of the poor maintenance of the Project, a high Economic Internal Rate of Return (about 27 per cent) was estimated, with a Benefit-Cost Ratio of 2.8:1. These estimates are fairly robust - they are not sensitive to changes in the key crop yield and fisheries loss assumptions.

Recommendations

Maintenance of the embankment has been non-existent. If the breaches continue to remain open then floods of moderate return period (perhaps 1-in-5 years) are likely to cause substantial damage. Means of achieving local participation in managing drainage (including

cuts) and in repairing the embankment are needed. Local investment in irrigation inlets might avoid embankment damage. Greater liaison between government departments is needed - earth road maintenance tends to be better than that of the embankment and the project embankment might be adopted as a local road. There is also an opportunity to manage the seasonal beels as a stocked fishery but collaboration between BWDB, DOF and NGOs would be needed to establish fishermen's cooperatives leasing or licensing the fishing rights.

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ABBREVIATIONS AND GLOSSARY

BARI	Bangladesh Agricultural Research Institute
BBS	Bangladesh Bureau of Statistics
BCR	Benefit Cost Ratio
beel	shallow water body
BIDS	Bangladesh Institute of Development Studies
BRDB	Bangladesh Rural Development Board
BWDB	Bangladesh Water Development Board
DTW	Deep tube-well (with positive-displacement pump)
EIP	Early Implementation Project
EIRR	Economic Internal Rate of Return
FAP	Flood Action Plan
FCD	Flood Control and Drainage
FCD/I	Flood Control Drainage and Irrigation
FPCO	Flood Plan Coordination Organisation
FAO	Food and Agricultural Organisation
FFW	Food For Work
ha	Hectare (2.47 acre)
HYV	High yielding variety
lakh	Hundred Thousand (100,000)
JICA	Japan International Cooperation Agency
khal	Natural channel
khalashi	Cleaner (actually guard) of regulator
LLP	Low Lift Pump
mt	metric tonne (1,000 kg., 2,204 lb.)
NGO	Non-goverment Organisation
O&M	Operation and Maintenance
Parishad	Council
PCR	Project Completion Report
pH	Positive Hydrogen Ion Concentration
PIE	Project Impact Evaluation
PP	Project Proforma
PWD	Public Works Datum
RRA	Rapid Rural Appraisal
SAE	Sub-Assistant Engineer
SCF	Shadow Conversion Factor
STW	Shallow tube-well (with suction pump)
SDE	Sub-Divisional Engineer
ODA	United Kingdom Overseas Development Administration
UAO	Upazila Agriculture Officer
UNO	Upazila Nirbahi Officer (principal staff officer of Upazila Parishad)
WA	Works Assistant

The Bengali Calendar

The Bengali calendar is almost exactly half a month out of phase with the Gregorian calendar, the months starting on the 15th to 17th of the Gregorian months. The year starts on 1st Baishakh, 15 April.

Bengali	Gregorian
Baishakh	April
Jaistha	May
Ashar	June
Sraban	July
Bhadra	August
Aswin	September
Kartik	October
Aghrayan	November
Poush	December
Magh	January
Falgun	February
Chaitra	March

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1 INTRODUCTION

1.1 THE FAP 12 STUDY

The FAP 12 Study is one of the 26 numbered component studies of the Bangladesh National Flood Action Plan, and is jointly supported by the United Kingdom Overseas Development Administration (ODA) and the Japan International Cooperation Agency (JICA). It is being carried out by a group of international and Bangladeshi consulting organisations comprising Hunting Technical Services Limited of the United Kingdom, Sanyu Consultants Inc. of Japan, the Bangladesh Institute of Development Studies (BIDS), the Flood Hazard Research Centre of Middlesex Polytechnic, UK, Hunting Fishtech of UK, and Technoconsult International Limited of Bangladesh.

The objective of FAP 12 is to conduct post-evaluations of a total of 17 projects representative, in type and location, of the FCDI projects so far executed in Bangladesh (see Figure 1.1). The results of these evaluations will be passed to other FAP components for guidance in developing strategies for improved flood control and management for the future.

Of the 17 projects for study, 5 will be assessed mainly by Project Impact Evaluation (PIE) methods, using a formal questionnaire approach and probability sampling. The remainder will be assessed by Rapid Rural Appraisal (RRA) techniques, and RRA is also being used for preliminary reconnaissance of the 5 PIE projects. The present report describes the findings of the RRA of Katakhali Khal Project.

1.2 RAPID RURAL APPRAISAL

RRA is a technique of project assessment intended to produce results more quickly than formal interview surveys, while avoiding biases in the data collected. RRA consists of selective direct observation and interviews of informed respondents from representative areas of the Project by a small team of well-qualified and experienced specialists who can reach informed judgements quickly in the field. Maximum use is made of documentary sources to minimise the amount of data which have to be collected by interview and to obtain guidance on the location and content of interviews.

In well-conducted RRAs great care is taken to avoid both locational biases (for example, observing/interviewing only in easily accessible areas) and socio-economic biases (for example, omitting coverage of women, landless people, and other groups which are difficult to identify, locate or obtain access to).

By its nature RRA is better at obtaining qualitative data than quantitative data, though it is generally possible to obtain fairly good quantified data on key agricultural parameters for the selected locations. What RRA cannot do (in contrast to PIE methods using probability sampling) is provide statistical validation of how far observations can be generalised over the Project area, or of differences between areas and time-periods. Its findings must therefore always be interpreted as informed judgements, not as precise statements with known margins of error. Further background to RRA will be found in the FAP 12 Methodology Report.

1.3 GENERAL LOCATION

Katakhali Khal Project is located about 25 miles (40 km) south of Jamalpur, and comprises the larger parts of one Union (Mahadan) of Sarishabari Upazila (Jamalpur District)

and one Union (Birtara) of Modhupur Upazila (Tangail District). The Project is bounded along its western side by the Jhinai river, which is connected to the Jamuna system (see Figure 1.2). The general area comprises a mixture of lowlying depressions and beels interspersed with slightly higher land. The Project was selected for RRA at random as a representative small FCD project completed after 1975 in the north-central region.

Existing roads and embankments have now protected much of the general area from smaller floods, although the general area was badly affected in the 1988 floods. There has been widespread development of groundwater for HYV Boro cultivation in the region, initially with deep tubewells (DTW) since about 1980, but mostly during the last few years with shallow tubewells (STW). At the same time the rivers were silting up and siltation of beels has made more land available for cultivation during the dry season. Hence, the experience of Katakhali Khal should be seen in the light of an agro-environment where changes were in any case happening.

1.4 KATAKHALI KHAL PROJECT

Katakhali Khal itself drained much of the Project area and flows into the Jhinai river. Before the Project the drainage channels and part of the Project area were open to water from outside, so flooding was reportedly a frequent event. An FCD project was appraised under EIP and was included in their 1980-81 programme. The Project was intended to be completed within the one season, but although work started on schedule it was in fact completed by June 1983.

The Project was subject to a short EIP appraisal (EIP, 1980) and to a socio-economic baseline study (Naqi, 1980). This indicated a small area of HYV Boro at the time, and that the main crops were: Aus, jute, B Aman and T Aman. The assessment (EIP, 1980) did not estimate flood losses, but claimed that the proposed project would bring two benefits:

- the monsoon water levels would be reduced - the maximum 1-in-5 year level inside the Project would be reduced by 5 feet (1.5 m); and

- the rate of rise in water during June/July would be slower - with a maximum of 4" (10 cm) per day.

Hence, the Project was not expected to eliminate monsoon season flooding from internal runoff (since water could not be drained out during high river stages). Even so, two benefits were predicted, one for each of the above targets:

- there would be an increased area under T. Aman, and higher yields; and

- there would be reduced flood damage and so higher average yields for the other monsoon season crops. It was also argued that Aus and jute areas would increase in response to this lower risk.

The works planned to achieve these aims were primarily structures. Much of the inflow of flood water came through Katakhali Khal, so a 3 or 4 vent regulator and closure were to be built there. Additionally a smaller bridge opening at Taltala allowed in water to a smaller beel system which connects into the main beel (Beel Balia) during high floods so a 1 vent regulator was to be built here (since the drainage is independent from the main khal). In total 8.8 miles (14 km) of embankment were to be built to prevent overbank flooding. This latter component may have been mis-specified in the feasibility study since according to the recast PP (Planning Commission, 1988) only 7.25 km of embankment were built, the remainder of

the earthwork being an existing earth road which was used as an embankment. In order to facilitate additional local drainage, two box sluices and two pipe sluices were planned. However, three box sluices were eventually built, to help drain the area protected by the earth road-cum-embankment. As Section 2 shows, the main regulator has in fact only three vents, despite being costed in the appraisal as 4 vents, and being shown in the recast PP (Planning Commission, 1988) as having 4 vents.

There is also a problem in defining the area impacted by the Project. The initial feasibility study (EIP, 1980) reported a catchment area for Katakhali Khal of 8,000 acres (3238 ha), a Project area of 6,575 acres (2661 ha), and a net benefited area (cultivated) of 5,500 acres (2226 ha). However, the benefited area shown on the map in EIP (1980) is inconsistent with the investments planned as it does not show the area benefited by the one vent regulator. However, the subsequent BWDB map of the completed Project, while indicating the area impacted by the one vent regulator, also excluded an area in the south-east corner of the earlier Project boundary (see Figure 1.2). It was found during the fieldwork that while this area drains through other khals to the south it nevertheless received flood water through the Project area and hence has been affected to some extent. It would appear that in planning the Project BWDB had an inadequate idea of the drainage pattern of the area and the areas likely to be affected by the Project. The recast PP merely repeats the gross and net areas given in the feasibility report. One of the tasks of the evaluation was to try to identify the area impacted by the Project.

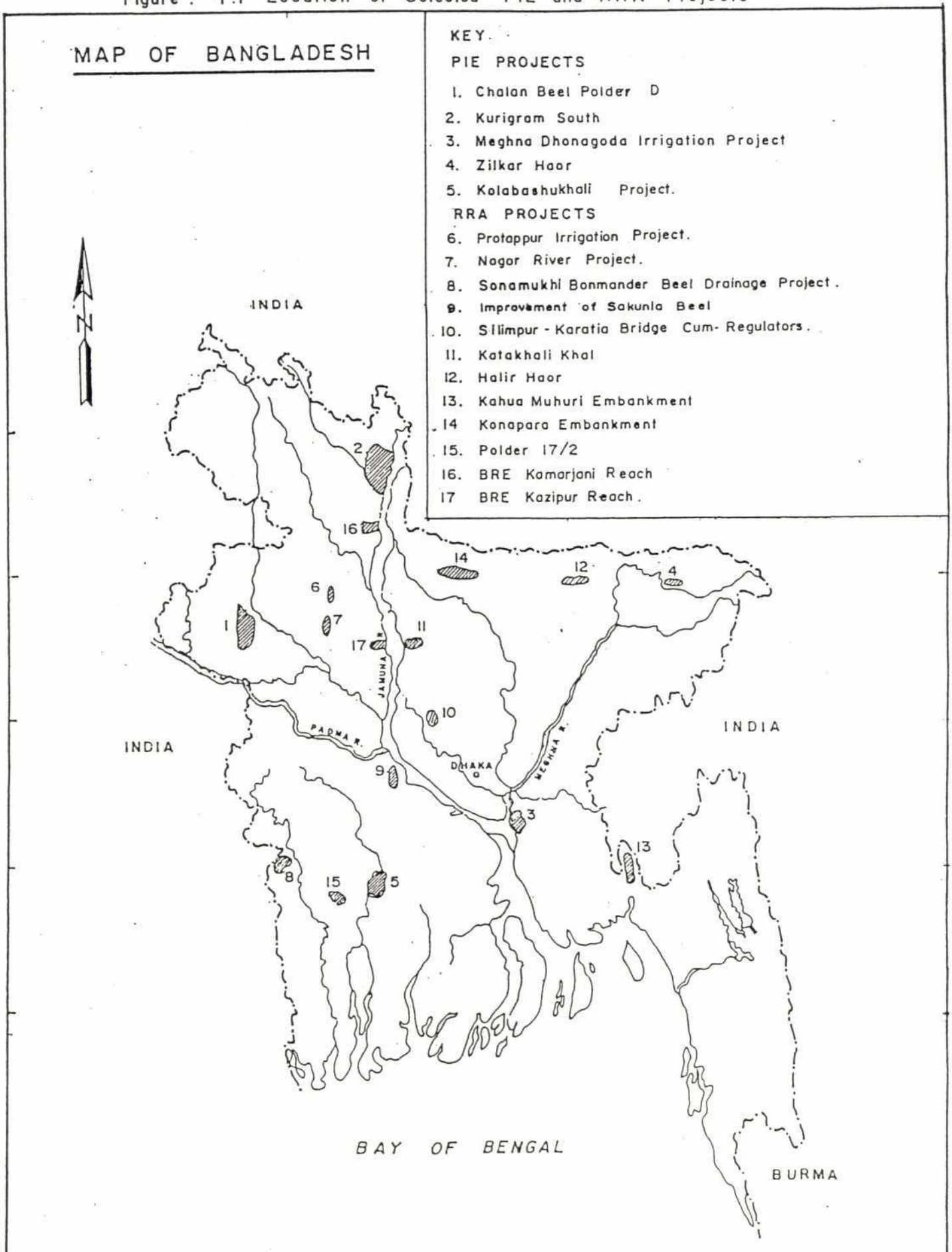
As this was an EIP Project there was some discussion of distributional impacts in the feasibility report. Some 47 per cent of households were landless in 1980 (half without homestead land). Although the report recognised that large and middle farmers would benefit most from the Project, it was reported that the area was in food deficit and even middle farmers did not achieve a surplus. The socio-economic study (Naqi, 1980) is largely descriptive but included questions about the proposed project. It reported that serious crop damage occurred in 1974, 1978, and 1979, and local people reportedly suggested the same engineering responses as were proposed in the Project. However, there was an expectation of low participation. Only half of the respondents said they would be willing to maintain the Project, and of these the majority (60 per cent) reportedly would participate only with government assistance (the others through Union Parishads or directly). Hence local support for the Project appeared to be modest.

There was no further discussion of other impacts, positive or negative, which the Project might have, either in the feasibility study or in the recast PP.

1.5 RRA ORGANISATION AND ACKNOWLEDGEMENTS

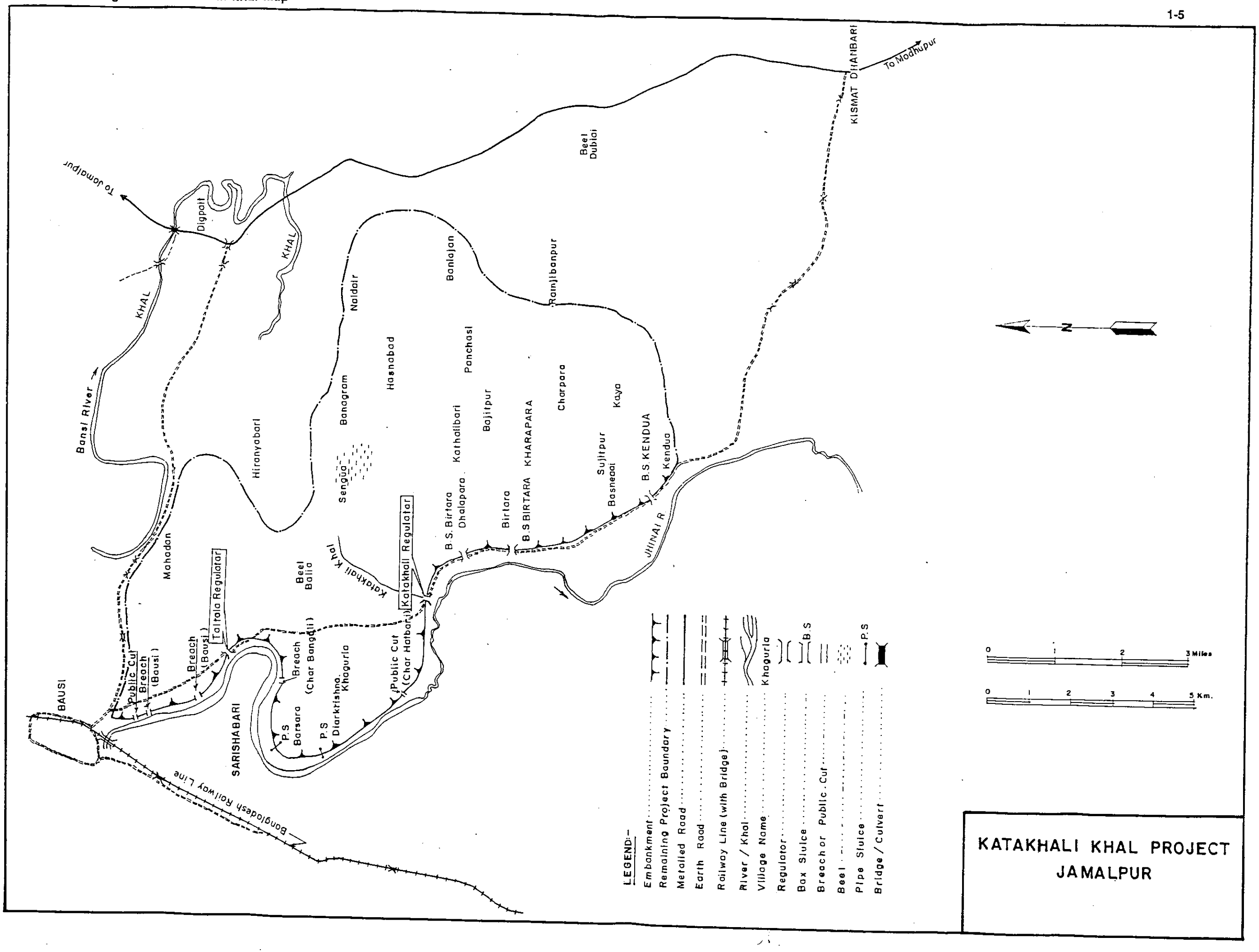
The RRA team comprised specialists in engineering, agriculture, fisheries, economics, institutions, and socio-economic impacts on women. Field work took place between 27 June and 3 July 1991 inclusive, and was based in Jamalpur. The team is grateful to the following for providing the information on which this study is based: BWDB staff, the Upazila officers of Sarishabari Upazila and Modhupur Upazila, Union Parishad Chairmen, large and small farmers, landless labourers, fishermen, and traders of the area. Discussions were held and observations were made in all of the villages within the tentatively identified Project area, although some more time might have been spent in some villages peripheral to the Project area claimed by BWDB. The BARI agricultural research station in Jamalpur kindly provided accommodation for the team.

Figure : 1.1 Location of Selected PIE and RRA Projects



Source: Consultants

Figure 1.2 Katakhali khal Map



2 ENGINEERING DESIGN, IMPLEMENTATION AND PERFORMANCE

2.1 PRE-PROJECT SITUATION

The Project area slopes gently from north to south. The entire Project area is low consisting of a good number of beels, except for the homesteads and some high cultivable lands. During the normal floods in the Jhinai river flood water entered into the Project area through the Katakhali Khal by back flow and often submerged the Aus, T. Aman and Jute crops, either at their early or maturing stages during the early and main monsoon season floods.

In the Feasibility Report (EIP 1980) there is no discussion of dry season cropping or intended impacts. However, the recast PP refers to an aim of reducing over-drainage to enable surface irrigation in the low lying areas. It is unclear if this was really a problem, or if the Project addressed it, since even the PP makes no estimate of a dry season benefit. There is no indication of the Project being operated in this way.

A water control structure (3-4 vent regulator) was proposed, following detailed field investigation and field survey, to cope with the dual problem of back flow and over drainage.

2.2 PROJECT OBJECTIVES

The Katakhali Khal Project aimed to construct an embankment along with two major regulators and four sluices (box/pipe) to provide flood control and drainage facilities to the Project area which was flooded from the Jhinai river, and also suffered over drainage through the Katakhali Khal.

The primary objective of the Project was to be attained mainly by providing flood protection during normal floods up to a 1-in-20 year flood.

2.3 SOURCES OF DATA COLLECTED

The following Project documents were used as sources of information in the RRA study: the recast PP (BWDB, 1988); the Project Completion Report (BWDB, 1986); the Feasibility Report (EIP 1980); and the socio-economic study by Naqi (1980). Interviews were also held with local Upazila officials, BWDB officials and local people.

2.4 ASSESSMENT OF PROJECT FEATURES

2.4.1 Project Infrastructure

The Katakhali Khal Project was officially declared complete in 1982-83. The engineering features of the Project as reported in the PCR are:

a) Length of embankment = 14.16 km. (8.8 miles)

Embankment crest elevation +54.6 ft. PWD
Embankment crest width 14 ft.
Cross dam width 14 ft. and crest elevation +57.2 ft. PWD
Side slopes 1:2 (embankment) both sides
1:3 (cross dam) both sides

[4.5 miles of new embankment, the rest being "resectioned", presumably the existing road]

b) Flushing-cum-drainage regulator = 2 Nos.

Regulator at Taltala Beel = 1 vent
Regulator at Katakhali Khal = 3 vents

c) 3 Box sluices and 2 pipe sluices are situated at the following locations

Box sluice at Kendua
Box sluice at Birtara Kharapara
Box sluice at Birtara Dholapara
Pipe sluice at Barsara of Mohadan Union
Pipe sluice at Diarkrishna of Satpoa Union

2.4.2 Structures

The two major flushing-cum-drainage regulators at Katakhali Khal and Taltala Beel were constructed to cover catchment areas of 12.6 square miles and 1.3 square miles respectively. However, there is found to be a difference in ventage of the Katakhali Khal regulator from the Project Proforma which originally specified 4 vents and was not even corrected to reflect the actual structure constructed. Moreover, there are actually three box sluices instead of two in the original proposal, and there is no written record available of the reasons for changes in Project planning. As no detailed design drawings or as built drawings were available for the structures it is not possible to verify the construction or understand the reasons for any change in the structures during execution.

A significant part of the top of the regulator at Taltala Beel was found to be exposed due to erosion of soil. Urgent maintenance of the embankment is needed to ensure its stability around the structure. The wooden fall-boards of this regulator need to be replaced by new ones because the existing ones are rotten.

The regulator at Katakhali Khal is in a defective condition as one gate is completely inoperative, and another can only be lifted halfway. The third is in full operation. According to BWDB the two defective gates were tested by the local technicians but they could not identify the problem. The concerned authority requested repair by technicians from the central mechanical workshop of BWDB. However, according to the regulator operator the two defective gates have been partly out of order for three years and the sluice committee is still awaiting a response from BWDB to its request for repair. In practice the gates can be closed, but this is reportedly much more difficult than it should be. Certainly efficient operation is hampered.

The box sluices appear to have been well constructed, which is to be expected as the original cost estimate was Tk. 3 lakh for two (EIP, 1980), but the final cost was Tk. 20.66 lakh (BWDB, 1986; Planning Commission, 1988) for three. Even allowing for annual inflation of 10 per cent this implies a construction cost 3.7 times higher than estimated, and a total cost higher than that of the three vent regulator, even though the box sluices serve much smaller areas.

The local people complained about the condition and difficulty in operation of the wooden fall-boards of the box and pipe sluices, which cause damage to crops in some cases. While these could be replaced by suitable lift gates to increase the operating efficiency of the sluices, this would be a further investment to benefit small areas.

The PCR (BWDB, 1986) claims that there are also four pipe outlets, but there is no budget line for this item, nor were any found by the team.

2.4.3 Embankment

The design crest of the embankment was fixed at +54.6 ft PWD to protect the Project area both from early floods and the main monsoon flood. The embankment could withstand the catastrophic flood of 1988 despite it being closer to a 1-in-100 year event in this area than the design standard flood of 1-in-20 years, and hence the embankment offers some benefit in greater than design standard events. There were some natural breaches in 1988 but these were influenced by public activity, such as digging the embankment down to ground level [totalling 6 ft. (1.83 m)] for use as an irrigation inlet and not closing it properly later on. This caused the embankment to breach naturally at the weak section. During the field visit by the RRA team it was understood from group discussion with the local people that the embankment was not overtopped, even in the 1988 flood, and they were able to take shelter on it.

However, the most northerly part of the embankment at Bausi appears not to have been constructed to the design level. Erosion, breaching and overtopping in 1988 all appeared to have occurred, based on the depths of water reported in houses and their floors relative to the river branch level. Water from this northern end of the Project flooded the whole area, despite the effort of people along the southern road-embankment to raise its level (successfully preventing local overtopping).

The whole embankment was found during this survey to be in a critical condition due to lack of maintenance since its construction and even due to damage by the 1988 flood. If it is not repaired and maintained in 1991 then it will endanger lives and damage crops in the 1991 and ensuing wet seasons.

There are a number of cuts and breaches in the embankment which remained open during the visit by RRA team. There was no evidence of BWDB or local initiative to close the embankment. Natural breaches and public cuts were observed at the following parts of the embankment:

a) Public cut at Bausi

This occurred in May 1991, due to drainage congestion caused by heavy precipitation over a short span of time. The embankment was cut to protect the standing jute crops. A very low bund of sandy soil has been built across this cut.

b) Natural breach at Bausi

This occurred during the 1988 flood due to removal of an old bridge by the local people, weakening this part of the embankment. It appears that an old bridge existed here which was sealed off by local people with earth to prevent flooding during the monsoon. When the embankment was taken up by BWDB they built the embankment around the bridge, without providing any drainage structure (Taltala regulator being intended to serve this area). However, two local powerful persons had the bricks removed (there were about 60,000 bricks) to build their houses. This loosened the earth and in the floods the embankment remains were washed away. Sand was locally deposited up to waist deep on land behind this breach.

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c) Natural breach at Char Bangali

This occurred in the 1988 flood due to digging the embankment down to ground level in order to irrigate from the river by LLP and not closing this part properly, creating a weak section.

d) Natural breach at Kalibari

This occurred in the 1988 flood and was due to the same reason as mentioned for Char Bangali.

e) Public cut at Char Hatbari

This was done in May, 1991 and was made to protect the HYV Boro and jute crops and homesteads from drainage congestion caused by heavy precipitation over a short span of time. This was to relieve drainage in an area bounded by the embankment and by an older earth road (the road which further south forms the Project embankment). There is no drainage structure in the southern part of this pocket of the Project and the culverts in the road are small. Project planning for this area appears to have been faulty. Even in early July 1991 water was still flowing out through the cut.

2.4.4 Interior of the Project

The construction and closing of the 14.16 km. (8.8 mile) embankment has prevented natural drainage in most parts of the area except the places where sluices are installed. Natural drainage appeared not to be improved as part of the Project. However, during the canal digging programme of the late 1970's a khal from Beel Balia to Bausi river was excavated, through which water could flow into the Bausi river. This khal has now silted up, creating a local drainage problem and damaging the standing crops. It is notable that this channel was dug away from the Project structures. There appears to have been a lack of coordination between project and programme, and a lack of local consultation.

The drainage channels (14 km.) leading to the drainage structures are now partly silted up and need to be re-excavated to augment their capacity so that the anticipated local drainage needs can be enhanced. Perhaps the real reason why this is seen as a problem is that the beels and khals have silted up, altering drainage conditions and putting in question the utility of expensive structures with long lives. In addition, HYV Boro is now widely grown, hence **broadcast** deep water Aman cannot be grown in the remaining flood conditions (which were expected to arise with the Project (EIP, 1980), but were probably never explained and discussed with local people).

While tall T.L. Aman varieties are grown, and late transplanting is practised, one can obviously see the benefits to farmers if water levels on lowland are reduced in the monsoon. However, extra sluices and khal re-excavation may not be a worthwhile expenditure, as yields would not increase by so much and water shortages on higher land might result; it may not even be feasible when monsoon river levels are high.

Another leading cause for local drainage congestion is the kutcha roads constructed under FFW programmes without any drainage facility or with insufficient culverts. To this extent farmers have a valid complaint and proper coordinated planning of all earthworks in the drainage system/project is required.

2.4.5 Irrigation System

Before the Project there was little irrigation - only by traditional means in low lying areas near the beels. However at about the time of the Project construction DTWs were introduced in the area. Subsequently, both in the Project and outside it, there has been a rapid growth in the numbers of STWs and now much of the area is irrigated in the rabi season. It might be argued that the Project offered security to this crop, but there is no evidence of early flooding from the river threatening Boro crops. On the contrary, drainage congestion due to the Project can cause damage to Boro if there is heavy rain before harvest, and this led to cuts in the embankment in 1991. Hence, irrigation would have developed in any case, although the area might have been less, given that the beels may have silted up faster because of flood protection.

2.5 OVERALL ENGINEERING/TECHNICAL ASSESSMENT OF PROJECT

2.5.1 Positive Impacts

a) Achievement of objectives

i) The Project has reduced the risk of flooding at elevations up to 54.6 ft. PWD in the Project area through the construction of the embankment.

ii) Both the early and monsoon water levels in general have been reduced by the construction of the embankment.

b) Other direct benefits of structures

i) The embankment has improved road communication; part is a road-cum-embankment which is used by rickshaw/vans, bullock and horse carts.

ii) The embankment is being used as a place of shelter by the inundated people in high floods.

iii) The embankment is used by goats and sheep for grazing.

iv) The water control structures (Regulators/Sluices) control the outflow of water from the Project so it is possible to cultivate fish seasonally in the beels to compensate for loss of wild fish. This already happens in some beels in the Project.

2.5.2 Negative Aspects/Impacts

a) Planning

Poor planning and implementation of the Project is shown by:

i) building the embankment over a masonry bridge without an outlet, and ignoring the local demand for the bricks (which were later on removed damaging the embankment);

ii) drainage facilities were not provided for areas cut off by existing roads and the embankments; and

iii) public cuts have been made to drain out early rain water which threatened Boro and jute crops.

b) Embankment

i) Some reaches of embankment have a crest level lower than the design standard due to lack of maintenance as resources are limited.

ii) The quality of resectioning some parts of the embankment under the Food-For-Work (FFW) programme is poor due to lack of compaction and lack of quality control. There are many rain cuts in the embankment.

iii) The embankment was breached in the 1988 floods, although this was greater than the design standard. The breaches have yet to be repaired.

iv) There has been no maintenance of the embankment since construction, and (obviously) no public participation in this. The numerous rain cuts have made the embankment very vulnerable to future floods.

v) Breaches and cuts in the embankment have resulted in sand deposition and loss of crops for several years.

vi) Uncontrolled irrigation inlets cut into the embankment have damaged its section and led to two of the breaches in 1988.

vii) The embankment may generate some false sense of security, for example in locating new houses, since severe flooding still occurred in 1988 (in a greater than 1-in-20 year flood).

c) Drainage

i) There is practically no internal drainage network to connect the low pockets to the existing drainage structures, which causes drainage congestion in the Project area.

ii) Two regulator gates are defective (the gear box on the vertical lift gates), which causes problems for timely drainage.

iii) Wooden fall-boards used in box sluices are repeatedly damaged in the flood season causing damage to crops by water from the river side.

iv) Drainage congestion due to silting up of the khals (which were never re-excavated), and the lack of outlets in some areas, still results in damage to Aman paddy, although this is less frequent than before the Project.

2.5.3 Recommendations

a) Design Review

The planning and design of the Project ought to be reassessed in the light of a changed agro-environment. Beels have silted up, internal roads have been built, and ground water irrigation is common. Changes to the drainage system may or may not be found necessary, but khal excavation and placement of cheap sluices should be considered. Local people should be involved in the choices of alternatives, and in understanding the limitations of gravity drainage.

b) Supplementary Drainage Structures

The negative drainage impacts of the internal road communication network should be reduced by proper placement of drainage structures.

c) Control of Irrigation Inlets

There is scope for supplementary irrigation from the river by LLP and additional irrigation inlets could be constructed by private individuals or irrigator groups. However, the standard of work must be improved and be checked by BWDB.

d) Maintenance

Regular maintenance of the embankment and structures is essential to avoid deterioration and damage. On the road-cum-embankment both the rain-cut surface and the slopes, such as they are, need maintenance.

e) Quality of Earthwork

The resectioning works of the embankments under FFW Programme should be coordinated by the BWDB concerned officials to maintain the minimum quality of compaction, so that reasonable durability can be ensured.

f) Repair of Public Cuts

It should be possible to arrange for repairing public cuts by the local people themselves since they organize themselves to make cuts in the first place when they are affected by serious drainage congestion.

g) Improvement of Regulators

Replacement of the wooden fall-boards of the sluices with vertical lift gates appears to be justified for easy and effective handling.

h) Beneficiary Maintenance of Embankment

The embankment might be made better use of, and kept in better condition, if rights to its use are created. A mixture of social forestry and grass production could be developed on this under-utilised land.

3 INSTITUTIONAL ARRANGEMENTS FOR THE PROJECT

3.1 PRE-PROJECT

Prior to Katakhali Khal Project there appeared to be no local institutional arrangements for water management in the Project area.

3.2 BWDB ROLE

As is usual in most small BWDB projects, the BWDB officer in immediate charge of the embankment in Katakhali Khal Project is the Sub-Divisional Engineer (SDE). He may delegate his authority to the Sectional Officer (SO). The next immediate charge is with the Work Assistant who is authorised to operate the regulator. In practice the regulators appear to be operated by local committees, and only the SO appeared to be informed about the Project.

There appears to be minimal, if any, liaison between BWDB and the two Upazilas (and Unions) covering the Project. The Upazila engineers appeared unaware of the Project, yet they have plans for implementing drainage works and village roads, bridges and culverts inside the Project area, and nearby, for at least the next three years. Both sides need to plan for the area in a coordinated way, keeping in mind the issues of water management (floods and drainage).

3.3 OPERATION

There was no specific O&M Manual for this Project. A semi-formal local institutional arrangement exists for Project operation, but not maintenance, but is given little institutional support. Operating responsibilities have been assigned to committees for the main regulators. The committees are functioning, but not without disputes.

The Taltala regulator is reported to have a committee of 7-9 members (their names are lodged with the BWDB SDE's office). The chairman is the largest landowner in the area. There is no BWDB involvement in operation. Originally the sluice was reported to have only been fitted with fall-boards, but some four years ago a vertical lift gate was installed. However, the regulator is reportedly rarely operated as cuts and breaches make it ineffective. The operator-secretary reported that he was unpaid and landless. It was unclear why he continued in this capacity.

The Katakhali Khal regulator operator has, reportedly, a similar unpaid post. There appears to be a khalashi shed by this regulator, although none is mentioned in the PCR (BWDB, 1986) and it is now a medicine store. There is no BWDB involvement in operation, which is determined by larger landowners in the northern part of the regulator's catchment.

3.4 MAINTENANCE

Public participation is not found in the maintenance of the Project. There has been no maintenance of the embankment since construction, except for the part which forms a village road. BWDB in general does not practice any well defined inspection and management system, and Katakhali Khal Project is not an exception to this.

3.5 ASSESSMENT OF INSTITUTIONAL ARRANGEMENTS

3.5.1 Positive aspects

Beneficiaries have formed sluice committees and are operating the sluices, but not without disputes. They have no formal status or accountability.

Local people were mobilised to protect part of the embankment when it was threatened by overtopping in 1988, but the efforts were not coordinated between Unions.

3.5.2 Negative aspects

Consultation between BWDB, the local administration, and the local people over project planning and operation and maintenance has been virtually non-existent.

There has been no maintenance of the embankment since construction and (obviously) no public participation in this. The numerous rain cuts make the embankment very vulnerable in future floods.

3.6 RECOMMENDATIONS

There should be a formal institutional framework for liaison between BWDB, Upazila and union administrations and representatives of farmers.

Responsibilities for operation and for maintenance need to be clearly defined.

A local role in embankment maintenance would facilitate providing repairs, ensuring cuts are repaired, and funding at least part of maintenance needs from local resources.

A cash or kind levy might be charged to the beneficiaries according to the extent of their benefit.

4. AGRICULTURAL IMPACT

4.1 LOCATION AND AREA

The Project is located on the left bank of the Jhinai river (Figure 1.2), about 25 miles south of Jamalpur town. The problems in defining the Project area have already been discussed in Section 1.4. The estimated Project area in EIP (1980) appears to be based on the areas of the villages surveyed, but the feasibility study Project map and current BWDB Project map are inconsistent. It was not possible for the Upazila Agricultural Officers to improve on these figures since the Project lies in parts of two Upazilas and it was unclear to the officials precisely which villages were affected. As part of the RRA the villages affected were identified and where part of a village appeared to be affected the proportion within the Project was estimated (based on the mouza boundaries shown in the Small Area Atlas for Jamalpur (BBS, 1986)), this gives an approximate gross impacted area of 3000 ha (7413 acres). However, this is still probably an underestimate.

4.2 PRE-PROJECT SITUATION

4.2.1 Land Type

According to FAO (1988) the Project area is in Agro-ecological subregion 8b - the Lower Brahmaputra Floodplain. This is a region of complex local relief comprising ridges and basins. The Project is no exception and contains a number of beels along with areas of relatively higher land. In pre-Project conditions the land was regarded as relatively fertile due to silt deposition during regular floods. The soils are dark grey floodplain soils with high moisture holding capacity and higher organic contents in the basin (beel) centres (see Section 11.1 for details of soil characteristics).

4.2.2 Flood condition and drainage

During the monsoon season (July-October), agricultural land normally received flood water, but the depth of flood water was dependent on the land level and severity of flooding. Farmers in the area classified their land as low, medium or high during group discussions. The depths of water and normal flood conditions reported for these categories varied between villages. According to the villagers the high land (about 18 per cent of the area of the villages surveyed) received either no flooding or 0.3-1 m. of flood water in normal conditions (Table 4.1); medium land (about 21 per cent of the area) was flooded regularly to a depth of 0.6-1.6m. (2-5 ft.), while low land (about 61 per cent of the area) received 1.6-3.1 m. (5-10 ft.) of flood water in almost every year (excepting years of abnormal floods). About seven per cent of the land remained normally flood-free and mainly comprised homesteads, markets, schools and roads.

In addition there were several beels (Table 4.2). Their extent fluctuated seasonally but the central parts of the beels were perennial with dry season water levels of mostly 0.9-1.2m. (3-4 ft.)(Table 4.2); as a result no crops were grown there.

It was learnt from the local people that before the project, during the monsoon, the river Jhinai over-flowed its banks and regularly inundated a large portion of the area (about 80 per cent). The flood water normally came in July and gradually receded in September.

Unusual floods and a sudden inflow of river water periodically caused damage to the standing crops (Aus, Jute and Aman) and the extent of damage could be as high as 80 per cent (as reported by the local people). The intensity of crop-damage was more along the river-side.

4.2.3 Crops and Cropping patterns

Pre-Project cropping patterns reflected the normal flood conditions encountered. Tables 4.3-4.5 give the detailed cropping patterns for 'high', 'medium' and 'low' land respectively in selected villages where group interviews were held. These are summarised in Table 4.6. This indicates that the dominant crops in the monsoon season were jute and TL Aman, with a lesser area of Aus and B Aman and a sizeable area of fallow land (mainly the areas with deep water in the beels). Mixed B Aus+Aman covered a relatively small area. By comparison, EIP (1980) estimated at the pre-Project time an even larger area (64 per cent of cultivable land) under T Aman, but the feasibility study estimates assumed that all cultivable land was cultivated in the monsoon season, and this would not appear to have been the case.

Dry season/winter cropping intensity was notably low with very little cropping of higher land, and pulses the main crop on medium-low land. However, 19 per cent of low land was reportedly under L Boro indicating more deeply flooded areas. Before the project neither HYV paddy crops nor wheat were reportedly grown in the Project area, but these crops were only just being introduced in the surrounding area at that time.

4.2.4 Inputs used

Before the Project silt deposition occurred on the land due to natural flooding, and farmers did not apply any chemical fertilizers on their crops. However, substantial quantities of cow dung were reportedly applied to the land before cultivation.

4.2.5 Crop Management

Before the Project the farming system involved relatively low labour inputs. Ploughing and weeding were done 3-4 times depending on the nature of crops. Jute needed an additional ploughing compared to other crops, whereas pulses were normally relayed into Aman fields without land preparation. Mulching twice per crop was reported for B. Aus, jute and rabi crops for better moisture retention and to reduce weed growth.

4.2.6 Yield

EIP (1980) only reported yields for the main paddy crops and jute. The figures given are very low compared with regional averages from the implementation period given in MPO (1987)(see Table 4.7). According to the recall of farmers, yields in the pre-Project period in a normal year were relatively good given the crop management system and varieties available.

For example, the average yield of B Aus reported by the farmers was 1.59 mt/ha (Table 4.7); the average combined yield of broadcast mixed Aus+Aman was almost identical to that of TL. Aman at 2.2 mt/ha; and jute yields were reportedly high at 2.4 mt/ha. These figures do not properly allow for flood damages. The frequency of damaging floods before the project is unclear, but EIP (1980) noted that complete crop failures had been reported for Aus and Aman during two of the previous five years. Farmers during the RRA reported that

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in a majority of years some of the crop was damaged - perhaps 40-50 per cent of the area of Aman but the extent of the damage is unclear.

It seems plausible to assume that floods in the range of 1-in-5 to 1-in-20 years return periods caused substantial damage, particularly given the relatively high acreage of T Aman (the project did not aim to protect against floods of greater severity than a 1-in-20 year flood and so damage from these extreme events can be ignored). It is unclear if the EIP (1980) yields reflect these risks, but they appear too low compared with the RRA yields. If the two sets of figures were consistent it would imply an excessively large adjustment downwards to the RRA figures to allow for flood damages, hence it is concluded that the EIP (1980) figures are underestimates of annual average yields.

4.3 OBJECTIVES OF THE PROJECT

The objectives of the project were very clear (EIP, 1980): to reduce the maximum water levels in a 1-in-5 year flood by about 5 ft and to reduce the rate of rise of monsoon water levels. The ultimate aim was thereby to increase the area under T Aman and to increase the average annual yields of both Aus and Aman crops. Hence it was expected that the area under T Aman would increase to 73 per cent of the net cultivated area and that the yield of all paddy crops would increase by 5 maunds/acre (see Table 4.7 for the predicted with Project yields, which in general are similar to those reported in the RRA for pre-Project conditions). There was no dry season objective in the project justification. Although not expressed in EIP (1980), it is apparent from the pre-Project conditions that a reduction in monsoon water levels might also be expected to increase the area under cultivation in that season.

4.4 POST-PROJECT AGRICULTURAL CONDITIONS

4.4.1 Floods and Drainage

Table 4.1 shows that in normal monsoon conditions the depth of water has been reduced on all land levels - in general high land is now flood free, medium land has 0.6-0.9m of water in the monsoon, and low land is under 1-3 m. of water. It is unclear what impact the project has had on the duration of normal flooding - in four villages duration of normal flooding was reported to be the same, in three it is apparently shorter, but in two it is longer, reflecting reports of drainage congestion.

Although flood damage was reported before the Project, at present monsoon rain water cannot drain out within a short time through the Taltala and Katakhali regulators; as a result water congestion occurs and reportedly causes nearly 40-50 per cent damage to Aus and Jute crops in some years. This reflects a mixture of problems: high river levels may make it impossible for gravity drainage of internal rain water flooding; the khals connecting the lowlying areas to the regulators are silted up (Section 2.4.4); there are pockets of land which are not connected to the drainage system such as it is; and there are openings in the embankment (cuts and breaches) which may in high flood years result in flooding from outside. Of note were public cuts in 1991 to release rainwater which threatened ripening Boro crops and which could not drain through the regulators because of local earth roads and poor embankment alignment.

In 1988 there was high flood damage to monsoon crops (about 95 per cent lost), but the Project was not designed to withstand such a high flood.

4.4.2 Crops and Cropping Pattern

Tables 4.3-4.5 give details of the cropping pattern reported in 1991 in a number of villages surveyed during the RRA. This is summarised in Table 4.6. It will be seen that a major change in the crops grown in the project area has occurred during all three main cropping seasons. As predicted there has been an expansion of T Aman. In fact B Aman appears to have disappeared from the area, and on higher land levels HYV Aman now replaces TL Aman. Almost all of these changes can be directly attributed to the Project. HYV Aman was not widely grown in 1980 and it is likely that some of the higher land could have grown HYV Aman instead of local varieties, but in the majority of cases the reduced normal monsoon water levels shown in Section 4.4.1 were necessary before farmers could switch from B Aman to TL Aman and from TL Aman to HYV Aman.

Very different changes occurred in the early monsoon season from those predicted: the areas of jute and Aus have declined to about 20 per cent and 10 per cent respectively of their former areas. Nevertheless on higher land jute is still an important crop, and the area may have been underestimated by farmers since some large areas of jute were observed during the RRA in the southern half of the project. This does not mean that the project would not have protected these crops had they been grown, but there has been a very dramatic increase in the winter cropped area due almost entirely to the introduction and expansion of groundwater irrigation for HYV Boro cultivation. STWs and DTWs are now widely used in the Project area, and in the areas visited, which are representative of the whole Project area, an average of 86 per cent of cultivable land is now under HYV Boro. This change has made it impossible to grow Aus or jute on land occupied by Boro paddy.

Hence previously cultivated areas have switched to Boro and a large area of land which had been fallow - either because it was too dry (higher land) or too wet (lower land) is now cultivated during the winter. There is no reason to believe that the FCD project has induced irrigation using ground water, and this would have been possible on higher land without the project. However, HYV Boro can be threatened by early floods and the Project might help in protecting against these. This possible benefit must be qualified, since HYV Boro may be threatened by drainage congestion and heavy internal rainfall despite the regulators. The timing of early floods in this area was normally not before June (EIP, 1980; and local farmer's reports). Hence Boro should have been harvested before flooding from the Jhinai River was likely. However, the beels in the Project appear to have dried up during the dry season enabling a larger area to be cultivated. It would appear that slower drainage within the project results in the deposition of silt, washed out from higher land in the project, in the beels rather than being carried out of the Project by flood water as in the pre-Project period. However, it is difficult to say to what extent this process might have happened without the project since earth roads provide both a source for such sediment and inhibit drainage, and beels would naturally have a tendency to slowly build up their beds.

4.4.3 Inputs

It is clear that on average the level of inputs per hectare has increased for two reasons: there has been a change to crops which require more inputs (particularly HYVs), and even for crops which were previously grown use of chemical fertilisers has become common where once only cow dung was used. Thus HYV Boro has replaced pulses and requires

ploughing, more labour inputs and chemical fertiliser. Similarly transplanted Aman (local varieties or HYVs) require more inputs that B Aman. Table 4.8 summarises input data collected in the RRA and compares these with data given in MPO (1987). Input estimates from group interviews are often unreliable. However, there is an unusually close agreement between the labour requirements estimated in the RRA from five villages and those reported in MPO (1987). It therefore appears reasonable for the post-evaluation to use the RRA labour input information, and supplement this with MPO (1987) data where necessary.

Information on chemical fertiliser application was only obtained for a few crops but indicates higher usage than MPO (1987). This may well be so since yield rates were also reported to be higher in the RRA (Table 4.7). It is uncertain what the rate of application of cow dung was before the Project so the increase in costs is uncertain. In general the frequency of tillage has probably declined for a given crop reflecting fewer draft animals per household and hence lower availability of own animals.

4.4.4 Yields

Yields of crops grown in both the pre- and post-Project periods appear to be little different. Table 4.7 suggests that jute yields may have declined (it may be grown on poorer quality land), and that TL Aman yields are slightly higher, which may reflect a benefit from flood protection. There is very good agreement between the yields reported by farmers in the RRA (averaged in this table) and those recorded by the Upazila Agricultural Officers for the blocks covering part of the project, suggesting that the figures are reliable, despite being higher than those given by MPO (1987) which in any case are now somewhat dated. Table 4.7 confirms that the change in cropping pattern has been to higher yielding crops - HYV Aman and HYV Boro yielding respectively 169 per cent and 227 per cent of the previous best paddy yields (TL Aman). There is a lack of evidence for a direct flood protection benefit for the same crops, particularly since some farmers reported that the yields given in Table 4.7 were not always achieved because of drainage congestion. Overall however there did not appear to have been serious damage since 1988.

4.4.5 Aggregate agricultural changes

Farmers' reports of increases in land prices suggest that relative land prices have changed to reflect the productivity of land. Thus for high land an average price of Tk 340 per decimal was reported in 1980 and Tk 956 per decimal in 1991 (a 2.81 times increase); for medium land the 1980 price was Tk 500 per decimal and in 1991 was Tk 923 per decimal (a 1.97 times increase); and for low land the 1980 price was Tk 242 per decimal and in 1991 was Tk 830 per decimal (a 3.43 times increase). Previously medium land had by far the highest cropping intensity averaging more than two crops a year (Table 4.6), but by 1991 there was very little difference in the cropping intensity or cropping pattern on medium and high land, while the only important difference on low land is the smaller percentage of land cultivated in the monsoon season.

Table 4.9 gives the total areas under the main crops based on Table 4.6, assuming that the gross impacted area of the Project is 3000 ha (Section 4.1) and that 84 per cent of this area is cultivable (EIP, 1980), that is 2520 ha of cultivable land. The cultivable area may have increased because of the project, but population pressure and expansion of rural roads may have eroded some of this potential gain so it is assumed for simplicity that the cultivable area has not changed. The total area per year under paddy crops has increased by 151 per cent and now represents a cropping intensity of 151 per cent. However, the associated

increase in paddy production has been 305 per cent, reflecting the switch to higher yielding varieties (HYV Boro instead of B Aus and HYV Aman instead of B and TL Aman). Food grain production has thus increased dramatically, but there has only been a modest increase in employment of 8 per cent (Table 4.9) since the growth in HYV Boro cultivation has been counterbalanced by the loss of Jute and B Aus and the slight fall in overall cropping intensity.

4.5 PROJECT IMPACTS

4.5.1 Positive impacts

There has clearly been a considerable expansion of crop production in the Project area since the Project. Some of these changes are not directly linked with the Project. There is no reason to believe that irrigation would not have been possible without the Project since it has spread rapidly in adjacent areas, but on low land the drying up of the beels has played a part and this may have been accelerated by the Project. Likewise the decline in kharif I cropping (Aus and jute) is a consequence of HYV Boro cultivation and not the Project. The following are considered to be positive impacts of the Project:

- normal monsoon water levels have been reduced, although not by as much as had been hoped;

- there has been a major switch in monsoon season crops from B Aman to T Aman, and from TL Aman to HYV Aman. On the whole this has been greater than predicted;

- monsoon paddy yields per ha are higher, but this reflects the changes in varieties rather than flood protection for the same varieties; and

- on low land an additional 35 per cent of the area is cultivated now compared with before the project. If the drying up of the beel periphery can be attributed to the Project then this benefit can be attributed to it (but not the change in cropping pattern on the low land which was already under cultivation, since this was due to irrigation);

- overall the Project has resulted in the production of some 2150 mt. of additional paddy in the monsoon season, and possibly in over 4000 mt. of HYV Boro paddy production.

4.5.2 Negative impacts

Drainage congestion due to silting up of khals (which were never re-excavated), and the lack of outlets in some areas, still results in damage to Aman paddy, although this is less frequent than before the project. In years of heavy and continuous rains, water congestion persists longer, causing damage to crops. The following problems were noted:

- T. Aman is partially submerged and is damaged;

- Jute is partly submerged and the quality and quantity of output is affected;

- sometimes water congestion due to early monsoon rains damages ripening HYV Boro crops. This, and poor planning of the drainage system, lead to public cuts. For example, in May 1991 people cut the embankment in the Char Hatbari area to drain out congested rain water to save their crops and properties.

Additionally, crop damage has occurred due to flooding from outside - in 1988 there was virtually no Aman crop (perhaps 95 per cent lost) due to the failure of the embankment. It should be remembered that the project was not designed to prevent such a flood, but nor were the potential consequences of failure anticipated.

Production of pulses and oilseeds has decreased with the changes in winter cropping patterns due to increased irrigation, but delayed drainage of congested water in late monsoon in medium and low lands prevents the growing of a short duration third crop (such as mustard) in between the Aman and HYV Boro crops.

There has been an increase in agricultural employment due to overall cropping changes, which are partly a result of the project. However, the gain for Aman cultivation is relatively small.

4.6 SUMMARY

About 90 per cent of the people of the Project area are dependent on agriculture for their livelihood directly or indirectly. The economic condition of the people had gradually been deteriorating because of failure of crops almost every year before the Project. After implementation of the Project two crops a year are more or less ensured, but the greater security is for the HYV Boro crop which would have been grown anyway once irrigation became widespread. Overall there has been substantial growth in agricultural production and it should be expected that the economic condition of the local people has improved substantially.

The potential agricultural gains from the Project have been limited to some extent by drainage congestion of internally generated run off during the monsoon. Of course gravity drainage is only possible when river levels are lower than internal water levels, but at present the Project is unable to drain adequately at times when conditions should make drainage possible.

One indirect impact on agriculture is that because floods no longer regularly damage Aman crops, there is less grazing available on fallow (post damage) fields.

4.7 RECOMMENDATIONS

a) Drainage

There is potential to increase annual average yields by improving the drainage system. Ultimately this depends on improved maintenance of khals and the regulators, and probably on better operation of the structures (which is hindered by the poorly maintained gates). It may be appropriate to establish farmers' groups in drainage congested areas which would have an agreement to cut and repair the embankment when required, given the lack of culverts and gated structures serving these areas.

b) Agronomic research

There has been a serious decline in pulse acreage, partly as a result of the Project, but mainly due to irrigation. This has implications not just for human nutrition (since dhal can

be imported), but also for nitrogen fixing and availability of fodder. There is scope for applied farming system research/trials in the area to see if:

- a short duration pulse crop could be squeezed into the current cropping pattern between paddy crops (for example, khesari, moong, or black gram); and

- alternative crops, such as sorghum, could be grown in the monsoon season in areas where water levels are not high at sowing time but are unpredictable.

4.8 SOURCES OF DATA

Sources of data used in the RRA were:

- interviews with officials including: Upazila Agricultural Officers, Upazila Chairman, UNO of Sharishabari Upazila, and BWDB office, Jamalpur. These provided information on the pre-Project condition and the impact of the Project, and on the conditions within and around the Project area;

- interviews with farmers of different villages within the Project, namely: Mahadan, Sengua, Hiranyabari, Banagram, Beel Balia, Naldair, Sirankazi, Panchasi, Kathaliabari, Bajitpur, Charpara, Kendua, Basneogi, Birtara, Kutirhat, Char-Hatbari and Khaguria. Farmers were interviewed in groups and also individually. At the time of interview cross checking was done to obtain more reliable information;

- interviews with traders in several bazaars including: Baushi Bangali; Kendua and Baldi Ata to investigate their opinions regarding pre-and post-Project conditions in the area;

- direct personal observation of land type, types and varieties of crops grown, inputs used and prevalence of pests and diseases;

- project documents referred to in the text, particularly EIP (1980); and

- other secondary sources including Small Area Atlas of Bangladesh (Tangail and Jamalpur districts) (BBS, 1986) and MPO (1987).

Table 4.1 Land levels and Flood Characteristics, Katakhali Khal

Village	percentage			Post-Project depth (ft)			Pre-Project depth (ft)			Duration of flooding
	High	Medium	Low	High	Medium	Low	High	Medium	Low	
Bajitpur	25	75	0	0	1-1½	-	2½-3	4	-	Shorter
Panchasi	0	25	75	-	0	4-5	-	2	7-8	Same
Kathaliabari	0	100	0	-	0	-	-	5	-	Shorter
Beel Balia	0	25	75	-	2-3	6	-	2-3	6	Same
Bonogram	25	0	75	0.5	-	8-9	1-2	-	10	Longer
Singua	25	0	75	0	-	8-10	3-4	-	10-12	Same
Mahadan	50	0	50	0.5	-	3	1	-	4-5	Shorter
Sujalkar	0	0	100	-	-	5-6	-	-	7-8	Longer
Char Hatbari	25	50	25	0	2-3	6-7	-	3-4	6-7	Same
Naldair	30	30	40	1-2	2-3	6-7	-	1-2	3-4	
Hiranyabari	25	50	25	1-2	3-5	7-9	-	2-3	3-4	
Beel Dublai ("outside")	-	-	100	-	-	6-7½	-	-	15'	

Source : Farmers group interview, 1991

Table 4.2 Beels and their Water Depth (ft) Pre- and Post-Project

Name of beels	Pre-Project		Post-Project	
	March	July	March	July
Taltala Dhao	5-6	8-9	4-5	5-6
Balia khas	4-5	8-9	2-3	5-6
Saitani Beel	4-5	5-6	0-1	4-5
Pailakuri	4-5	6-8	0-1	4-5
Peri Beel	3-4	5-6	0-1	3-4
Khoilshakrui	3-4	5-6	0-1	3-4
Tengrakuri	3-4	5-6	0-0.5	3-4
Balia Beel	3-4	6-7	-	4-5

Source : Farmers group interview, 1991

Table 4.3 Cropping Pattern, High Land, Katakhali Khal

Villages	Pre-Project						Post-Project					
	Winter		Aus		Aman		Winter		Aus		Aman	
	Crop	Intensity	Crop	Intensity	Crop	Intensity	Crop	Intensity	Crop	Intensity	Crop	Intensity
Bonogram	Others	10%	B. Aus	25%	TL. Aman	90%	HYV Boro	75%	Aus	8%	HYV Aman	90%
			Jute	75%			Oilseed	10%	Jute	25%	LT Aman	10%
							Others	10%				
Sengua	Others	12%	Jute	75%	TL. Aman	88%	HYV Boro	75%	Jute	20%	T. HYV Aman	50%
			B. Aus	25%			Others	1%			LT Aman	50%
Mahadan	Oilseed	5%	Aus	40%	TL. Aman	75%	HYV Boro	90%	Jute	10%	HYV Aman	90%
	Pulses	5%	Jute	60%			Others	10%				

Source: Farmers' interviews

Table 4.4 Cropping Pattern, Medium Land, Katakhali Khal

Villages	Pre-Project						Post-Project					
	Winter		Aus		Aman		Winter		Aus		Aman	
	Crop	Intensity	Crop	Intensity	Crop	Intensity	Crop	Intensity	Crop	Intensity	Crop	Intensity
Bajitpur	Pulses	25%	B. Aus	28%	TL. Aman	75%	HYV Boro	80%	Jute	10%	HYV Aman	80%
	Oilseed	10%	Jute	47%	B.Aus+Aman	25%	Wheat	10%			TL. Aman	20%
	Chillies	10%					Oilseed	10%				
Panchasi	Oilseed	20%	Jute	100%	TL. Aman	60%	Wheat	60%	Jute	60%	HYV Aman	38%
	Pulses	8%					Oilseed	20%	B. Aus	40%	TL Aman	23%
							Pulses	8%				
Kathaliabari	Pulses	30%	B.Aus+Aman		25%		HYV Boro	65%	Jute	25%	TL. Aman	90%
	Oilseed	10%	Jute	25%	TL. Aman	75%	Wheat	10%				
	Chillies	10%	B. Aus	50%			Mustard	5%				
	Potato	5%					Potato	5%				
	Brinjal	5%										
Beel Balia	Pulses	50%	Jute	50%	TL. Aman	100%	HYV Boro	90%	Jute	5%	T. HYV Aman	70%
	Oilseed	10%	Aus	50%							TL. Aman	30%
	Chillies	5%										
	Onions	10%										

Source: Farmers' interviews

Table 4.5 Cropping Pattern, Low Land, Katakhali Khal

Villages	Pre-Project						Post-Project					
	Winter		Aus		Aman		Winter		Aus		Aman	
	Crop	Intensity	Crop	Intensity	Crop	Intensity	Crop	Intensity	Crop	Intensity	Crop	Intensity
Panchasi	Pulses	66%	B. Aus + Aman		66%		HYV Boro	100%	-	-	HYV Aman	33%
											TL Aman	33%
Beel Balia	Pulses	50%	B. Aus + Aman		20%		HYV Boro	100%	-	-	-	-
	Oilseeds	10%	B. Aus	20%								
	Onions	5%	Jute	60%								
	Others	10%										
Bonogram	Pulses	75%	Jute	50%	B. Aman	45%	HYV Boro	100%	-	-	TL. Aman	70%
					T. Aman	45%						
Sengua	L. Boro	75%			B. Aman	13%	HYV Boro	62%	-	-	-	-
							Others	25%				
Mahadan	Oilseed	12%	Jute	60%	TL. Aman	75%	HYV Boro	90%	Jute	5%	HYV Aman	60%
	Pulses	12%	B. Aus	40%			Others	5%			TL Aman	30%
Sujalkar	Pulse	10%	B. Aus + Aman		30%		HYV Boro	70%	Jute	30%	TL. Aman	80%
	Oilseed	10%	Jute	50%	TL. Aman	70%	Others	5%	T. Aus	10%		
			B. Aus	20%								
Beel Dublai	L. Boro	10%			B. Aman	25%	HYV Boro	95%			TL. Aman	50%

Source: Farmers' interviews

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Table 4.6 Aggregate Cropping Pattern of Survey Villages, Katakhali Khal

	Pre-Project (% Cultivable Area)				Post-Project (% Cultivable Area)			
	H	M	L	All	H	M	L	All
HYV Boro	0	0	0	0	84	68	93	86
L Boro	0	0	19	12	0	0	0	0
Wheat	0	0	0	0	0	13	0	3
Oilseed	3	11	5	6	1	7	0	2
Pulses	3	31	31	28	0	1	0	0
Potatoes	0	2	0	0	0	2	0	0
Chillies	0	8	2	3	0	0	0	0
Others[1]	5	4	1	2	8	0	7	6
Jute	66	43	34	42	15	20	3	9
B Aus	34	39	13	22	1	4	1	2
B Aus+Aman	0	17	13	12	0	0	0	0
B Aman	0	0	12	8	0	0	0	0
TL Aman	81	79	24	46	15	52	30	32
HYV Aman	0	0	0	0	79	39	14	31
Cultivated Area of Villages Surveyed (ha.)	208	238	696	1142	208	238	696	1142
Cropping Intensity	192	234	154	181	203	206	149	171

Source: Table 4.1, 4.3, 4.5
Note: 1 include small areas of named rabi crops.

Table 4.7 Comparison of Yields of Main Crops (mt./ha.)

Crop	Reported by farmers		Upazila[1] (1990/91)	EIP (1980) and Planning Commission (1981)		MPO (1987) 1980/81-82/83[2]
	Pre-project (1981)	Post-project (1991)		Pre-project	Post-project (estimate)	
HYV Boro	NA	5.18	5.22			4.04
L Boro	2.95	-	2.67			2.10
Wheat	-	1.99	2.05			1.62
Oilseeds	.82	.77	N Avail			0.71
Pulses	2.0	-	N Avail			0.68
Potatoes	3.24	5.11	N Avail			8.94
Jute	2.43	2.12	1.97	1.18	1.48	1.40
B. Aus	1.59	2.21[3]	1.35	0.98	1.48	1.22
T. Aus			2.67			3.41
B. Aus+Aman	2.21	-	-			
B. Aman	1.53	-	-	0.98	1.48	1.60
TL. Aman	2.28	2.61	2.36	1.48	1.97	1.62
HYV Aman	-	3.85	3.74			2.66

Notes: 1 Information from Kotomtoli, Kirdua and Birldiata Blocks, Modhupur Upazila (UAO)

2 North-east region

3 Increase in yield is due to part of the Aus area now being under T Aus

Sources: see column headings

Table 4.8 Input Use for Main Crops at Katakhali Khal

Crop	RRA group interviews			MPO (1987) North-east region			
	Labour d/ha	Chemical Fertilizer (kg/ha)	Number of tillages	Labour d/ha	Chemical fertilizer kg/ha	Plough days	Seed kg
HYV Boro[3]	189	480	2-3	213	193	52	30
L Boro				156	34	40	30
Wheat	124	189	.2-3	93	123	40	130
Oilseed	71	123	2[1]	71	103	36	10
Pulses	60	none	none	45	none	30	30
Potatoes	206		5	194	115	49	1000
Chillis	247		4				
Others							
Jute	185		5	210	45	48	9
B Aus			4	146	27	44	100
B Aus+Aman	206	none	4				
B Aman	82	none	4	107	none	42	100
TL Aman	124	100	2	130	32	42	30
HYV Aman	124	288	2-3	165	112	45	30
Price (1991)	Tk 21.5/day		Tk 910/ha[2]				

Note: 1 - None used pre-Project;
2 - Normal Control Rate plough or power tiller;
3 - Irrigation at Tk. 2470/ha

Sources: See colum headings

Table 4.9 Aggregate Changes (Pre-Project) in Cropped Area, Output and Agricultural Employment

Crop	Area (ha)		Output (mt)[1]		Labour requirement (person days)[2]	
	Pre-Project	Post-Project	Pre-Project	Post-Project	Pre-Project	Post-Project
HYV Boro	0	2167	0	11225	0	409563
L Boro	302	0	891	0	47112	0
Wheat	0	76	0	146	0	9424
Oilseed	151	50	124	39	10721	3550
Pulses	706	0	1412	0	42360	0
Potatoes	8	8	26	41	1648	1648
Chillies	76	0	?	0	18772	0
Others[1]	50	151	?	?	?	?
Jute	1058	227	2571	481	195730	41995
B Aus	554	50	881	110	80884	7300
B Aus+Aman	302	0	667	0	62212	0
B Aman	202	0	309	0	16564	0
TL Aman	1159	806	2643	2104	143716	99944
HYV Aman	0	781	0	3007	0	96844
Total Paddy	2519	3804	5391	16446	619719[3]	670268[3]

Note: 1 - Based on RRA yields in Table 4.7
2 - Based on Table 4.8, RRA data where available, otherwise MPO (1987)
3 - Total for all crops

Source: RRA survey unless otherwise noted

Table 4.10 Miscellaneous Agricultural Information

Name of village	% of landless people	% of people having own plough	% of people who hired plough	Rate of hiring plough Tk./deci.	No of rat pits/acre	Names of weeds present (local names)
Naldair	25	75	25	10	15	Moisham, Dubba, Bhadail
Banagram	25	70	30	2	10	Bhadail, Dubba, Gobra, Goicha
Hiranyabari	20	75	25	2	8	Moisham, Bhadail, Dubba
Sengua	25	70	30	4	10	Bhadail, Dubba, Moisham
Mahadan	15	80	20	2	8	Dubba, Bhadail, Gobra, Kayna, Chaicha, Goicha
Beel Balia	25	70	30	2	10	Dubba, Bhadail, Moisham, Araila
Char-Hatbari	25	75	25	4	20	Moisham, Dubba, Bhadail, Araila, Goicha, Haicha
Kathaliabari	25	25	75	2	20	Dubba, Gobra, Gabshi, Moisham, Bhadail
Panchasi	25	90	10	10	10	Bhadail, Dubba
Sujalkar	20	70	30	4	8	Gobra, Chaicha, Goicha, Dubba, Araila, Bhadail
Average	23	70	30	4	12	

Source : Farmers interview, 1991

5 LIVESTOCK

5.1 PRE-PROJECT SITUATION

No benchmark information on livestock could be traced in the Project reports and documents consulted. Therefore, information presented in this report on the pre-Project livestock situation is based mainly on interviews and discussions with local officials, elites and farmers during the field visit.

It was reported by the farmers of the locality that there were sufficient areas of grazing land before the Project and almost all the households used to keep a good number of livestock. The Aman fields which became fallow due to monsoon flood were used as grazing land by the farmers. Fallow lands were also sufficiently available for grazing cattle during the Boro season as HYV Boro cultivation was not widespread.

Various types of green grasses were also available in the low lying areas. In addition to green grass, rice straw was an important cattle feed in the locality. Next to cattle, goats were the most important animals in the Project area. Almost every household used to rear poultry, which is the common practice of rural women in Bangladesh.

5.2 PROJECT OBJECTIVES

Livestock were totally neglected in Project planning. Therefore, any specific objective for livestock cannot be expected in the Project documents. In general, overall animal health is deteriorating in the country due to a shortage of feed. As an agricultural development project, the Project planning should have taken a farming system view and considered any implications for livestock (both draught demand and fodder needs). However, most of the problems have arisen from private irrigation development which BWDB might not be expected to react to.

5.3 SOURCES OF DATA

The main sources of information were the Upazila officials, villagers and elites within the Project area. During the RRA fieldwork attempts were made to cover almost the entire area of the Project by visiting all the mouzas within it. People were interviewed individually and in groups, in the homestead, in the fields and by the side of the road. Information collected from one person or group was cross-checked with other persons or groups. Besides, information was also collected from the official records of the Upazila Livestock Offices. Data were also recorded from personal observation. The information collected from the Upazila offices is presented in Table 5.1.

5.4 POSITIVE IMPACTS

The Project had some direct and indirect positive effects on livestock after its implementation:

a) Availability of Bulk Fodder

Partly as a result of the Project the gross area under paddy has increased (Chapter 4). This has resulted in increased production of rice and its byproducts. Since 1980 output of rice straw and rice bran have reportedly increased by about 30-35 per cent and 35-40 per cent respectively.

b) Increased Poultry Production

Since 1980 the poultry population has also increased by 25-30 per cent. This increase in the poultry population can be attributed to increased production of rice bran, because in the rural areas rice bran is the cheapest and most readily available poultry feed. Egg production has increased with the increase in poultry population. An increase in egg production per hen and per duck has also been reported by the Upazila Officers (Table 5.1).

c) Increased Goat Population

The goat population has also increased. However this increase cannot be related to the Project impact, but it might be due to increased numbers of landless, marginal and small farm families. Most of these households rear goats by the side of roads and embankments and in the fallow land, as a source of cash income.

5.5 NEGATIVE EFFECTS

a) Loss of Grazing Land

The area of fallow and grazing land has declined by about 60-70 per cent since 1980 with the increased area of rice cultivation. Better protection of the Project area from monsoon flood has helped Aman crops, while Boro cultivation has reportedly expanded within the Project.

b) Decline in Cattle Population

The cattle population has also decreased after the Project by about 40-45 per cent. The decrease in the area of grazing land may have limited the scope for rearing and keeping cattle by the farmers of the locality.

c) Shortage of Draught Power

The consequent decrease in cattle population has resulted in a great shortage of draft power within the Project. The draft power requirement is claimed to have increased by about 40-50 per cent. The farmers meet this requirement by hiring power tillers at the rate of Tk. 900/ha/complete tillage, or bullock ploughs at Tk. 400-450/ha/complete tillage.

d) Decline in Milk Production

After the Project milk production has also decreased by 30-40 per cent due to decrease in quality feeds, especially green feedstuffs.

e) Decline in Animal Health

The general health and condition of the animals within the Project area was not found to be good. This may be associated with the shortage of grazing land and quality feeds.

5.6 MEASURES TO CORRECT NEGATIVE IMPACTS

The Project was completed in 1982-1983. During the last decade a number of problems, particularly for cattle, have developed in the locality. However, the following measures could be undertaken to minimise these adverse effects on livestock.

a) Improved Fodder Crop Production .

The Project has had an adverse effect, specially on the availability of quality feeds, by reducing the area of grazing land. It may be possible to grow fodder crops (cow pea, khesari and maize) and forage crops (napier grass, and para grass) on fallow land, between the existing crop seasons. In some cases such crops might be grown on the embankment slopes and road sides. However, this would effectively replace common grazing land and would need to be managed so as to reduce the erosion of the embankments and roads. Although production of rice straw has increased after the Project, it cannot alone meet feed requirements and maintain the normal health of the animals due to the presence of relatively low amount of nutrients. Therefore, due importance should be given to green feed production. This can be achieved by intensifying the extension activity in the Project area by the Upazila Livestock Officer. One of the Upazila Livestock Officers has already made good progress on improved feed production in the nearby Unions of Madhupur Upazila by taking up a feed production programme.

b) Improved Digestibility of Paddy Straw

Agronomic research on HYV paddy should also pay attention to the palatability of straw. The digestibility of straw could be increased by treating it with urea. This would also improve the nutrient status of straw by increasing its nitrogen content.

c) Improved Disease Control

There are also non-Project related trends which are important. It has been reported by the villagers in the Project area that high mortality of poultry and cattle occurs every year due to outbreak of contagious diseases, such as foot-and-mouth disease, cattle diarrhoea, fowl pox, and rani-khet. To overcome these losses preventive measures could be taken by initiating routine vaccination programmes in the region.

d) Distribution of Improved Strains

To mitigate the losses and to improve the quality and quantity of cattle and poultry, regular insemination and cockerel exchange programmes should be undertaken. This might improve the cattle quality and numbers, and also increase the protein intake of the rural people by way of increasing production of eggs, meat and milk.

5.7 LESSONS LEARNED

It has been learnt from discussion with the officials of different organizations that there is no co-ordination between BWDB and other officials. There should be good co-ordination between the BWDB and other nation building organizations. The departments of Livestock and Agriculture and Fisheries should be involved with project planning from the very beginning to facilitate appropriate measures so that fisheries and livestock are least affected after the implementation of the Project.

Table 5.1 Information on Livestock for Madhupur and Sarishabari Upazilas

i) Changes since 1980

Items	Madhupur	Sarishabari
a) Green feed	Increased	Decreased
b) Grazing land	Decreased	Decreased
c) Straw quality	Decreased	Decreased
d) Milk production	Increased	Decreased
e) Egg production/hens	Increased	Increased
f) Egg production/ducks	Increased	Increased
g) Health condition of animal	Not good	Not good
h) Draft power shortage/sufficient	Shortage	Shortage

ii) Prices of meat and other products (1991 in Tk.)

Item	Madhupur	Sarishabari
a) Cattle (meat/kg)	40-50	45-55
b) Goat (meat/kg)	60-80	60-70
c) Chicken (kg)	55-65	40-50
d) Duck (kg)	30-40	35-40
e) Sheep (meat/kg)	60-80	60-70
f) Buffalo (meat/kg)	35-40	35-40
g) Milk (kg)	16-20	10-14

Sources : Upazila Livestock Officials.

6 FISHERIES

6.1 PRE-PROJECT SITUATION

Although the Project was completed in 1982-83 (BWDB, 1986) there is no information about the pre-Project fisheries situation in the documents and reports consulted. However, before the Project the water from the Jhinai river entered freely into the Project area through Katakhali Khal, and during high floods water also entered into the Project area by overtopping the banks (EIP, 1980). While causing frequent damage these annual floods connected the waterbodies of the Project to the main river system.

According to the Socio-economic Report (Naqi, 1980) there were seven beels (namely Taltala beel, Beel Balia, Khalshakuri beel, Parvati beel, Saitani beel, Bula beel and Peri beel) within the Project area. All these beels over flooded during the monsoon, and most of the beels contained sufficient water to support fish round the year as reported by the villagers and fishermen. They also reported that these beels, khals and rivers abounded with different species of fish. This abundance started declining after Project implementation. Fishermen used to depend on these water bodies for fishing and maintaining their livelihood.

6.2 OBJECTIVES

Since it has been already mentioned that there is no information on fisheries in the Project documents, the question of a specific fisheries objective in these documents does not arise. Fisheries were totally neglected in the Project planning. Had it seen the importance of fisheries as the main source of income of at least some groups of people, and as an important source of animal protein, the BWDB could have set some development targets for fisheries in project planning to mitigate the losses due to the Project.

6.3 SOURCES OF DATA

Attempts were made to collect necessary information from the available documents and reports. Related officials were then interviewed to collect information. Attempts were also made to collect information from the different types of people in the Project area during RRA study. The main sources of data in the field for RRA study were fishermen, farmers, fish culturists, fish traders and local leaders. They were interviewed individually and in groups along the road side, in the fields and markets, by the side of beels and rivers, and in their homesteads. Information was also collected from relevant persons of areas adjacent to the Project.

Information collected from one person or group was cross-checked with other persons or groups. In this way all the mouzas in the Project area were visited during the RRA study. The assessment is also based on personal experience as gained from actual field observation of the existing Project situation. Some of the data on fisheries obtained from the Upazila Fisheries Officers and Fisheries Directorate are presented in Tables 6.1 and 6.2.

6.4 POSITIVE IMPACTS

The Project has had a few direct or indirect positive effects on fisheries.

The embankment constructed along the left bank of the river Jhinai has effectively protected the Project area from monsoon flooding, and thereby created better security and scope for pond fish culture in the relatively lowlying areas.

The sharp decrease in overall fish production, and better protection of ponds from monsoon flooding, have created awareness among pond owners of the benefits of stocking fish in their ponds. The farmers in the relatively high land areas have constructed new ponds to culture fish. In certain villages the number of ponds has increased by about 80-100 per cent after the Project. The great decrease of fish stock in the beels and rivers has also created awareness among fishermen and villagers of the need to stock fish in the beels adjacent to their villages. It was reported by the inhabitants of Kaguria village that they released fish fingerlings of carp costing about Tk.30,000 in Kaguria beel during the last year, and at the end of the year they sold out the fish for about Tk. 200,000.

Increased pond fish culture has also opened a new avenue of income generation among the local fishermen, who now catch fish on contract for the pond owners.

6.5 NEGATIVE IMPACTS

The implementation of the Project has left an adverse effect on capture fisheries.

The flood protection embankment and structures along the bank of the Jhinai river have prevented the entrance of flood water from the river into the Project area during the monsoon. This embankment has thus blocked migratory fishes from entering and leaving the Project area. As a result of this blockage fish production has decreased by about 70-80 per cent in beels and khals within the Project area and by 50-60 per cent in the adjacent river Jhinai. This has also resulted in a change in the species composition of fish in the beels. In particular, the important commercial species had already disappeared by 1991. Only the small forage fishes, such as magur, koi, shingi, and tengra are now available. The species of fish which are available and no longer available at present are shown in Table 6.3, and the fisheries situation in the related Upazilas in Tables 6.1 and 6.4.

Due to the embankment, the water bodies within the Project area now dry up annually, and the fishermen and villagers catch whatever fish they can. This practice of catching all fish leaves no stock for future breeding and recruitment. If this practice continues for a longer period, a time will come when there will be hardly any fish to harvest from the beels and khals. The changes of aquatic habitats from lotic (free-flowing) to lentic (static) have encouraged siltation and sedimentation within the Project and thus the beels and khals are now silting up at an alarming rate. This silting up of water bodies is also greatly enhanced by the erosion of newly constructed roads in the locality. The surface water irrigation from these water bodies is also greatly responsible for their early drying up.

Fish production in the adjacent rivers has also decreased due to increased fishing pressure. The fishermen who used to depend mostly on water bodies within the Project for fishing before its implementation have now intensified their fishing in the river due to reduction of fish stocks within the Project. Table 6.2 shows the decreasing trend of riverine fisheries in greater Mymensingh district. The Katakhali Khal which used to carry carp and other fish fry and fingerlings into the Bangsi river before the Project is now blocked by the embankment, closures and structures. Thus the fishery in the Bangsi river is also adversely affected by the Project.

Moreover, the Project has reduced the catch and income of fishermen. Before the Project the fishermen used to catch about 6-8 kg of fish a day, but now the catch has been reduced to ½ kg. to 1 kg. Their income has also declined by 40-50 per cent. The Project has had an adverse effect on fishing as a profession. Nowadays the fishermen cannot depend solely on fishing as the amount of catch has sharply decreased. As a result most of the fishermen have adopted subsidiary professions such as daily labour, crop cultivation and petty trading, in addition to fishing as their main profession.

The Project has also adversely affected the income of the fish traders. Due to the decrease in fish production the income of the fish traders has fallen by about 50-60 per cent. The quantity of fish handled by them has also been reduced from 10-12 kg/trader/day to 2-3 kg/trader/day.

Before the Project fishermen used to catch fish almost round the year. The annual drying up of water bodies has shortened their fishing period after Project implementation.

6.6 POSSIBLE MEASURES TO CORRECT NEGATIVE IMPACTS

Since the Project was implemented in the early 1980s, its adverse effect on the fisheries resources of the locality is long standing and severe. Therefore, it is not possible to regain the original state by adopting any development programme. However, an attempt can be made to mitigate the losses due to the Project by undertaking some development measures.

Since the ponds within the Project are now free from floods, attempts should be made to increase pond fish production by introducing improved fish culture practices through intensive and widespread extension activities. The pond owners were found to culture fish in their ponds by traditional methods and as such the yield obtained by them is very poor. A special extension programme should be made within the Project area to bring all the ponds and water bodies under more productive commercial fish culture.

Appropriate measures should be taken so that genuine fishermen obtain fishing rights in the water bodies. The present lease systems always deprive genuine fishermen of their legal rights because of undue interference by rich and influential persons. The fishermen cannot compete with the rich in leasing the water bodies. The influential persons lease the water bodies in the name of local fishermens' cooperatives. Instead of leasing out the water bodies the fishermen should be given fishing rights by issuing fishing licences as provided for under the New Fisheries Management Policy.

Arrangements should be made to introduce improved fish culture in the beels and khals after their reclamation. To achieve this goal these water bodies should be re-excavated to increase their water holding capacity. This will provide scope for the fishermen and villagers to culture fish in them instead of their drying up annually. The fishermen can provide shelter to fish by placing branches of trees into these water bodies. This will prevent fish from going out of them to a great extent.

General research and experiments in sluice designs and project plans to facilitate the migration of fishes from river to Project and vice versa are needed.

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6.7 LESSONS LEARNED

The BWDB did not collect baseline information on fisheries, nor did it estimate the probable effects of the Project after its implementation on water bodies, fish production and the fishing community. There should be appropriate base line studies of fisheries reported in the Project documents of future projects, to plan mitigatory measures and so that future evaluations can assess project impacts. This is especially necessary when the losses to fisheries due to FCD projects are relatively large, as shown in this Project, where both the quantity of fish and the diversity of fish were very greatly reduced.

No coordination was found between the BWDB officials and other government officials (including Department of Fisheries). Good co-ordination between the officials of different government agencies is a pre-requisite for effective project planning and implementation.

In future project planning, the related officials, especially fisheries, livestock and agriculture, should be involved in order to have a clear picture of the pre-Project situation and likely impacts on different aspects of the Project area. This will help greatly in integrating the FCD/I projects with future development programmes within the Project area more fruitfully.

Table 6.1 Information on Fisheries for Sarishabari and Madhupur Upazilas

a) Water bodies with number, area and yield of fish

Type	Madhupur Upazila			Sarishabari Upazila		
	Number	Area	Fish Yield (MT/Yr)	Number	Area	Fish Yield (MT/Yr)
Rivers	2	5.57 km^2	15.00	-	-	-
Khals	15	0.78 "	10.00	-	-	-
Beels	65	265 ha	163.75	-	-	-
Total Ponds	1407	259 ha	762.00	712	149 ha	-
Cultivated ponds	1121	206 ha	-	590	126 ha	-
Cultivable ponds	200	40 ha	-	122	23 ha	-
Derelict ponds	86	13 "	-			
Total			950.75			185

b) Fishing Community

Items	Madhupur UZ	Sarishabari UZ
No. of fishing families	297	2500
No. of fishermen	544	15000
No. of fisherman cooperative	2	2
No. of cooperative member	231	-

c) **Fish Price** (Per Kg. in 1991)

1) Rui and Katal (Big) = Tk.80-100
2) Rui and Katal (small) = Tk.50-60
3) Other carps = Tk.45-60
4) Small fish = Tk.35-45
5) Small shrimp = Tk.30-35
6) Magur & Koi = Tk.60-70
7) Shingi = Tk.55-60

Source : "a" and "b" from Upazila Fishery Officers and "c" from interview and discussion with fishermen, fish traders and farmers.

Table 6.2 Fish Production Trends in Mymensingh District

i) Riverine Fisheries :					
Major Group of Fish	Year-wise Catch (MT)				
	1983/84	1984/85	1985/86	1986/87	1987/88
Major Carps	1,394	3,034	172	126	100
Other Carps	609	1,339	433	344	309
Catfish	1,004	2,191	670	576	433
Live fish	272	. 589	1	26	0
Hilsa	484	708	299	31	2
Big Shrimp	142	240	25	31	11
Small Shrimp	0	304	1,118	451	215
Other Species	4,474	9,188	7,132	8,843	11,062
Total	8,379	17,593	9,850	10,428	12,132
ii) Beel Fisheries :					
a) Area (Acre)	29,406	29,406	29,406	29,406	29,406
b) Catch (MT)	13,233	13,734	12,811	13,152	13,479
iii) Floodland :					
a) Catch	7,374	6,731	11,030	12,434	12,437
iv) Pond Fisheries :					
a) Area (Acre)	21,841	21,841	21,841	21,841	21,841
b) Catch (MT)	8,435	7,450	7,227	7,769	9,551

Source: Department of Fisheries, Fish Catch Statistics of Bangladesh.

Table 6.3 Species of Fish Affected by the Project

a)	**Adversely affected species:**		
i)	Major carps:	*Labeo rohita*	Rui
		Labeo calbasu	Kalibaus
		Catla catla	Katal
		Cirrhina mrigala	Mrigal
ii)	Minor carps:	*Labeo gonius*	Ghonia
		Labeo nandina	Nandina, Nandil
		Cirrhina reba	Bagna
iii)	Other fishes:	*Mystus aor*	Aeir
		Mystus seenghala	Guzi
		Notopterus chitala	Chital
		Notopterus notopterus	Fali
		Wallago atu	Boal
		Ompok pabda	Pabda
		Nandus naandus	Bheda
		Gadusia chapra	Chapila
iv)	Shrimp:	*Macrobrachium* sp.	Chingri
b)	**Relatively less affected species**		
i)	Snake head:	*Channa punctatus*	Taki
		Channa striatus	Shol
		Channa marulius	Gajar
ii)	Catfish:	*Clarius batrachus*	Magur
		Heteropneustes fossilis	Shingi
		Mystus tengara	Tengra
		Mystus sp.	
iii)	Other fishes:	*Puntius* spp.	Puti
		Amblypharyngodon mola	Mola
		Rohtee cotio	Dhela
		Esomus danricus	Darkina
		Oxygaster spp.	Chela
		Ailia coila	Kajuli
		Pseudeutropius atherinoides	Batasi
		Botia dario	Rani
		Lepidocephalus guntes	Gutum
		Colisa spp.	Kholisa
		Mastacembelus puncalus	Guchi Baim
		Anabas testudibeus	Koi
		Glossogobius giuris	Ballya
		Ambassis nama	Chanda
		Ambassis ranga	Ranga chanda

Table 6.4 Fisheries Information for Birtara Union, Madhupur Upazila

a) Water bodies with number, area and yield of fish.

Types of water body	1985			1990		
	Number	Area	Yield	Number	Area	Yield
Total Ponds	69	9.3 ha		130	18.2 ha	9.1 MT
Cultured ponds	60	7.8 ha		125	17.0 ha	-
Culturable ponds	0			0		
Derelict ponds	9	1.5 ha		5	1.2 ha	-
Beels	2	5.0 ha		2	5.0 ha	3.8 MT
Khal	1	3.9 km		1	3.9 km	1.1 MT

b) Particulars on fishing community

Items	1985	1990
No. of fishermen	30	15
No. of fishermen adopted other profession	-	20
No. of fishermen cooperative	0	0

Source: Upazila Fisheries Officer Madhupur.

Notes : About 50% of Birtara Union falls within the Project.

7 OTHER ECONOMIC IMPACTS

7.1 SOURCES OF DATA

The socio-economic baseline survey (Naqi 1980) gives relatively little information on non-farm employment or on agricultural labour. Most information collected during the fieldwork is based on discussions with farmers and landless labourers in the Project area. Additionally traders were interviewed in Digpait, one of the main trade centres/transport nodes adjacent to the Project.

This Chapter discusses changes in agricultural employment, other employment, trade, and non-agricultural flood losses, and the extent to which changes are due to the Project.

7.2 PROJECT OBJECTIVES

The feasibility study did not include estimates of the additional employment which might be generated by construction, maintenance, or in agriculture following predicted cropping changes. Some benefits of this nature might have been expected, and the recast PP (Planning Commission, 1988) estimated that 217,000 person days of labour would have been generated during construction (it does not report if this was achieved and it is thus impossible to evaluate the direct employment generation from project construction). The recast PP also estimated that an additional 55,000 days of agricultural labour per year would be created through increased cropping intensities. No wider economic development aims were discussed.

7.3 AGRICULTURAL EMPLOYMENT TRENDS

7.3.1 Introduction

Since the main source of employment for landless labourers is agriculture and both before the Project and now a large part of the population of Katakhali Khal Project is landless, the employment impacts are clearly important. The impacts have been considered in two ways: from discussions with labourers, the peak and slack seasons before and after the Project were identified, and current wage rates estimated; and from the cropping patterns and labour requirements reported by farmers, the implications for on farm employment can be estimated.

7.3.2 Labour demand

There was wide agreement between villages on the current employment pattern in agriculture, reflecting the growth of HYV Boro cultivation (Chapter 4) throughout the area. The main employment peak is now at the Boro harvest in Baishak-Jaistha (mid-April to mid-June). There are lesser employment peaks for Aman transplanting in Shrabon-Bhadra (mid-July to mid-September), and for the Aman harvest and Boro transplanting in Agrahan-Poush (mid-November to mid-January). The slack periods are the early and late monsoon periods: Ashar (June-July) and Ashin-Kartik (mid-September to mid-November). By comparison in the pre-Project period there was a longer period of relatively high labour demand (compared with the slack periods then) which peaked in Jaistha-Ashar for the Jute harvest, but there was also relatively more work reported in Shrabon-Bhadra. The timing of labour demand has thus been altered by changes in the cropping pattern, but this is largely a product of small scale irrigation.

Wage rates indicate that there is, relative to some parts of the country, reasonable availability of employment: in 1990-91 wages in the peak seasons averaged Tk 26 (range Tk 20-30) with three meals per day, while in normal-low demand months the wage rate averages Tk 16 (range Tk 12-20) again with three meals a day.

There was less agreement on the overall trend in employment within the Project area. In a few higher villages it was reported that there was relatively more work before the Project because there was more Jute grown, and therefore a high demand for labour for Jute harvesting and processing and for transplanting Aman during a concentrated period, and also because dhones were more widely used for irrigating L Boro in low areas. Very locally breaches which resulted in sand deposition had also reduced the cultivated area for several seasons, hence reducing availability of work. However, there was a majority view that the changes in the Project area had increased availability of agricultural employment. Some people even estimated a 60-100 per cent increase in work availability. However, the population has also grown during the same period.

7.3.3 Labour requirements for cultivation

Chapter 4 (Table 4.9) gives an estimate of the increase in employment in cultivation since the Project of about 50,500 person days a year, or about 8 per cent. This is much less than some labourers estimated, although the increased peaks in labour demand for two transplanted paddy crops are likely to mean that relatively more hired labour is used since the Project. However, this change is due almost entirely to the growth in HYV Boro cultivation. In the Aman season agricultural work has actually declined by a small amount. Overall there appears to have been very little benefit from the Project for landless labourers.

7.4 OTHER MALE EMPLOYMENT

Employment opportunities outside agriculture are limited. Before the Project there were very few other economic activities, while now those which have developed are largely outside the Project: nearby jute mills; brickfields; and construction work. The only notable change for male employment within the Project comes from the growth in local roads - there are now more rickshaws, vans, bullock and horse carts plying the earth roads than previously, a reflection of higher production. There has been some decline in boat transport (although this was not of any great significance in pre-Project conditions), and there is now a denser earth road network linking the Project area to improved pucca roads outside the Project. Although flood protection will have some benefit in reducing damage to roads, it is not clear whether more roads have been built because of the Project. There is a similar network of roads, and similar plans for further FFW roads, in other parts of these two Upazilas (according to their plan books).

Despite the reported increase in agricultural employment in the Project area, there also appears to have been an increase in the number of people migrating outside for work. In a few villages only some 10 per cent of households were reported to have members working outside, but in most cases it was reported that 25 per cent or more migrated, with up to 75 per cent going out of the Project area for work during the lean season. Previously fewer households were reported to be dependent on labouring outside the area.

Hence, there appears to have been very little growth in small scale industries linked with the Project.

7.5 TRADE

7.5.1 Introduction

Chapter 6 noted that small scale fish traders had suffered a loss of income as a consequence of the Project. However, discussions with traders and transport hauliers revealed different trends in primary product trade involving the Project area. While trade generates some additional income for the area, a greater local value added could be achieved with local processing and agro-industries, but this does not appear to have been encouraged within the Project area itself.

7.5.2 Pre-Project conditions

Before the Project (in about 1980) there were reportedly only about 15 paddy traders in the Unions comprising and surrounding the Project (namely Mohadan, Birtara, Digpait, Titpolla, and Roshanidpur). At that time some 80 per cent of the limited amount of paddy entering the market from this area (Project and surrounding areas) was from the Aman crop, with about 13 per cent from Aus and a very small amount of Boro paddy. Very little paddy was bought from the Project area at that time (perhaps 1-2 per cent of the paddy entering this market). In fact 10-15 per cent of the paddy passing through the traders' hands was reported to have been **sold** to people from the Project area, indicating that it was a deficit area compared to nearby Unions. Moreover, at that time there was in abnormal years trade in rice which was brought into the area, for example in years of high flood damage.

7.5.3 Post-Project conditions

HYV Boro production started in the area in about 1980. It has been continuing to rise ever since and the traders reported that the trend was still rising. Now the main period when paddy enters trade is April to September (after the Boro harvest) and about 70 per cent of paddy traded is HYV Boro with the remainder Aman paddy. However, this change in source of paddy ignores the phenomenal increase in the amount traded: there are now about 100 paddy traders in the same area (7 times increase), and they reported that the volume of paddy being traded had increased 16 times between 1980 and 1990-91. While the greater part of this still comes from outside the Project area, about 30 per cent of the traded paddy reportedly comes from the two Unions in which the Project lies. This means that the Project area has changed from a paddy deficit area to a surplus producing area.

The bulk of this change is clearly due to HYV Boro production; as shown in Chapter 4 there is very little linkage between this and the Project, and the same trends can be found in adjacent areas outside the Project. However, if the reports of traders are correct they imply that in aggregate there has also been a six times increase in the amount of Aman paddy traded from the whole area. It was not possible to determine whether Aman paddy from the Project area is traded to this extent.

Although most of the paddy is sold direct to big rice mills outside the area, there has been a development of smaller paddy parboiling and milling units in the area. It was reported that there are three in Mohidan and one in Birtara Unions. Hence a part of the increased grain production has had a linkage effect on the local economy, but this is limited by the lack of surfaced road communications within the Project area (even if the Project area is less flood prone, locations just outside with road access for trucks are preferred).

The down side of this trend is that as a result of the growth in Boro production there has been a major decline in the jute trade (reportedly down by 60 per cent compared with 1980).

These changes are largely a result of irrigation, but it would appear that Aman production has also been increasing. To the extent that the Katakhali Khal area was previously more flood prone than Unions further from the main rivers, this suggests that the Project has at least helped the area to keep up with general agricultural trends.

7.6 NON-AGRICULTURAL FLOOD LOSSES

There are a mixture of medium-high and low lying mouzas within the Project area. Although homesteads were always on relatively high land, there was some variation in reports of flood damage frequency during the pre-Project period. Flood damage to crops was widely reported to have been common before the Project, with large areas (for example 50 per cent of lower land) affected in some measure each year (see Chapter 4). However, damage to homesteads was reported never to have happened in some villages, while in nearby villages it was said that some houses were damaged once every 2-3 years; in a number of villages people remembered 1974 as the most damaging pre-Project flood.

The EIP Project was designed to provide a 1-in-20 year standard of protection (EIP, 1980). Hence it is not surprising that in 1988 the whole Project area was severely affected by flooding. Water entered the area from the north-western side of the Project; EIP (1980) noted that there is a slope through the area from north to south, so the overtopping and breaches at the northern end led to flooding over the rest of the Project area. This was despite the Birtara UP chairman mobilising local people to build up the embankment in their (southern) part of the Project to avoid overtopping there.

Reports of the extent of flood damage in 1988 varied (see Table 7.1) but it was clearly severe. Many households moved out of their flooded and collapsed homes and took shelter on the embankment and the roads. Most were able to save their possessions, but there were livestock losses. The majority of houses are kutcha - constructed with thatched roofs of straw or grass and jute stick walls. An average size house of this type (about 15' by 10', 4.5m by 3m) was reported to have present construction costs of about Tk 1000. Thatching in any case is replaced every year on average (so if lost this has little **economic** impact or value). Grass is the preferred material and is bought from outside the Project. It costs Tk 10 per bundle (kori) and 20 bundles would thatch the typical house (Tk 200). Straw has similar costs. Jute sticks are reported to last up to 20 years (but this seems over optimistic). About 80 one hath (18 inch circumference) bundles at Tk 5 are needed, a total cost of Tk 400. Smaller numbers of houses constructed of earth, tin (in several cases walls and roofs), and brick/concrete are found in the area.

Hence if it is assumed that jute stick houses collapse and that the roof would be replaced anyway, and that some of the structure (bamboo or wood) survives, then the loss would be about Tk 600-700 in materials - the opportunity cost of labour for house building will be low but not zero given the need to recover income in a post flood situation (by outside work and replanting crops, according to circumstances).

Based on Table 7.1, in 1988 about 35 per cent of houses collapsed due to flood damage, and there were about 6075 households in the Project area (BWDB definition) in 1981 (analysis of data in Small Area Atlas). This implies that there was a loss of at least Tk 1.38 million from this housing damage. This ignores population growth and household formation after 1981, partial damage, damage to other buildings (kitchens, stores, second houses, for

example), and ignores damage to contents and possessions. Hence even with the Project an extreme flood can cause considerable non-crop damage, which is particularly important for the poorest households; for about 50 per cent of households (landless) this is all they have and their houses are more likely to collapse than those of rich households.

This experience at least provides some recent evidence of the extent of flood losses, but more importantly it emphasises that flooding is still a real risk within FCD Projects. The more extreme events which cause such flooding are likely to damage large numbers of houses and most of the crops growing at the time. Hence emergency planning and means of warning people, who settle in lower places than during the pre-Project period (because of the sense of security generated by such projects and pressure of population), are essential to cope with such events within FCD projects.

7.7 CONCLUSIONS

7.7.1 Positive Impacts

i. Some increase in on-farm employment has occurred, partly due to the Project.

ii. Overall, trade has increased, partly due to the Project. There has been some development of additional employment opportunities but these are largely outside the Project area itself.

iii. Internal transport on earth roads has developed in the area; increased production and reduced frequency of floods are among the factors behind this.

7.7.2 Negative Impacts

i. FCD alone has not encouraged the growth of small scale industries, even though agricultural production has increased.

ii. No employment in maintenance of the Project has been generated.

iii. There is still a risk of significant flood losses from greater than design flood events.

7.7.3 Recommendations and Lessons

i. Designing embankments combined with roads in anticipation of agricultural changes and increased marketing of produce might facilitate local economic growth, but care is needed as it is equally likely to cut out the role of poor people in transporting materials by rickshaw/van.

ii. The risk of flooding does not disappear with a project. Floods which occur despite FCD are likely to cause maximum disruption and high damages. Local people are likely to regard the risk as less severe with a project and so will be in greater need of warnings of overtopping or embankment failure. Flood plain planning on the part of BWDB, Upazila and Union Parishads could help in reminding people of the real risk (when houses and roads are built) and in coping with emergencies - identifying safe places, and mobilising voluntary labour to raise embankments in an emergency, for example.

Table 7.1 Housing Damage Reported in Katakhali Khal Project from 1988 Floods

Village name	1981 no households	typical depth water in houses (m)	percentage houses affected	percentage houses collapsed	comments
Bajitpur	217	0	none	none	Some houses built on lower land since Project.
Bangali	2354	0.9m	100%	50%	Refers to 5% of mouza inside Project, where affected by breach.
Panchasi	428	0.6m	?	30%	All earth houses (30% of houses) collapsed.
Kataliabari	239	0.3-0.9m	90%	38%	
Sengua	697	0.3-0.6m	majority	50%	Even chairman's house flooded to 15" (water stain on furniture). Standard of replacement houses lower.
Mahadan	474	0.15-1m	60%	few	Generally higher village.
Sujalkar	121	0.6-0.7m	80%	50%	

Sources: group interviews and 1981 population census

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8 IMPACT ON NUTRITION AND HEALTH

8.1 DATA SOURCES

Discussion with the officials of the Upazila Health Offices and interviews with the villagers were the only sources of data on nutrition and health conditions. However, these only provided qualitative information, since quantification is not possible using this approach. Information was collected from the above sources regarding food intake over the year and the type of food, both at present and before the Project.

8.2 PROJECT OBJECTIVE

Improvement of nutritional and health status was not explicitly within the purview of the Project. However, the objective of increasing agricultural production and the wellbeing of the households in the Project area through controlling flood water can be translated into the implicit objective of improving nutrition and health status of the villagers. Moreover, the socio-economic appraisal (Naqi, 1980) recommended the Project "to save a great many people of the Project area from starvation". Increased production would not only increase the supply of foodstuffs, but also can ensure increased employment, which in turn can increase peoples' purchasing power.

8.3 PRESENT NUTRITIONAL STATUS

8.3.1 Food consumption

The number of households which can have three meals a day throughout the year is very small (only 8-10 per cent). This is, however, a little higher than ten years before when only 5-6 per cent of the households could have three meals a day throughout the year. Another 35-40 per cent of households were able to have two meals a day. The rest (about 50 per cent) of the households could have 1-2 meals a day depending upon the availability of food. If they were unable to get rice they used to eat "inferior" foods such as wheat, kheshari pulses, and sweet potato.

During the months of Baishakh, Jaistha, Ashar, Agrahayan and Poush (mid-April to mid-July and mid-November to mid-January) almost 60-70 per cent of households can eat three meals a day. About 25-30 per cent of households can eat two meals a day during these months. However, in the months of Ashar (June-July) and Kartik (October-November) the number of households having three meals a day reduces to only 25-30 per cent, and most of the households can eat only two meals a day. Falgon and Chaitra (mid-February to mid-April) are the months of food shortage since this is the period just before the Boro harvest. At this time most of the people can have only one meal a day.

Consumption of vegetables is reported to be higher than in the pre-Project period since control of flood water due to the embankment helped to increase vegetable gardening in the homestead areas. Fish consumption has been reduced by almost 60-70 per cent since fish production in the beel areas has decreased. The decrease in the livestock population has also had a negative impact on protein consumption. Although the number of poultry, and thus egg production, has increased, the consumption of chicken and eggs has not increased due to lack of purchasing power. Fruit consumption has also decreased by about 50 per cent, associated with the loss of trees (Chapter 11).

8.3.2 Water Supplies and Health Condition

Almost all the families have access to tubewells for drinking water. Nearly 30 per cent of the households use pond water for cooking and washing clothes. Ninetyeight per cent of the households do not have pucca latrines which creates health hazards.

The people of the area, especially the children, suffer mostly from nutritional deficit which is the result of lack of protein. Diarrhoea is common among the children and anaemia is common among the women. Medical facilities have increased compared with before, but this is not related to the Project.

8.4 COMPARISON WITH PRE-PROJECT CONDITIONS AND PROJECT IMPACT

8.4.1 Positive Impacts

Food consumption as a whole has increased compared with before the Project, which is partly the impact of the Project but mainly due to HYV Boro cultivation.

8.4.2 Negative Impacts

Consumption of protein is reduced due to a reduction in fish production and the livestock population; both are linked to the Project, loss of fish consumption from casual fishing and purchase being a particularly detrimental impact of the Project.

8.4.3 Other Trends

Health problems in the area have become acute, although health care facilities (in terms of hospital and doctors) have increased since 1980. About 60 per cent of the villagers now suffer from gastric problems, which were not experienced to the same extent before. However, this phenomenon is by no means related to the Project.

9 IMPACT ON WOMEN

9.1 DATA SOURCES

Since there was no existing information on the status of women in the Project area the only source of data was interviews with both men and women in the villages during the RRA. Discussions with Upazila and NGO officials at the local level also helped to explain the impact of the Project on women.

9.2 PROJECT OBJECTIVE

There was no explicit objective to improve the condition of women in terms of increased employment opportunities and income through the Project. However, what can be inferred from the main objective of the Project is that an increase in agricultural output would create employment opportunities for a greater number of women in the area during the post-harvest period.

Moreover, the scope for embankment maintenance work for women might also be within the purview of indirect objectives of the Project.

9.3 PRE-PROJECT SITUATION

Pre-Project, activities of women in the Katakhali Khal Project area were mostly within the homestead area. Women from poor families used to find agricultural processing work in the rich households in the post-harvest period (during the months of Agrahayan and Poush, mid-November to mid-January). Looking after livestock and poultry and homestead gardening were also among the activities of women.

9.4 POST-PROJECT SITUATION

9.4.1 Post-Harvest Activities

Post-harvest activities of women in the Project area have increased since agricultural production (mainly paddy production) has increased. During the months of Baishakh, Jaistha, Agrahayan and Poush the workload on women increases compared to other months of the year. They have to perform a number of tasks such as threshing, parboiling and drying paddy. Women labourers get three meals a day in addition to which they get half a maund of paddy or rice or in some cases one saree per season. The introduction of rice mills has replaced much of women's paddy husking activities (previously all by dheki) which has reduced the duration of post-harvest agricultural activities in the peak season. A few workers (about 15-20 per cent) in the rice mills are women.

9.4.2 Other Activities

There are still some fishing families in the Project area. Women of these fishing families help the fishermen by repairing fishing nets.

Vegetable production in the homestead area has increased, which again has increased the extent of work of the women. This was possible partly because of flood protection, and partly of necessity as families attempt to replace the loss of other foods (fish and pulses, for

example). Increased poultry keeping has in turn increased the responsibility of looking after poultry by women. This helps the women to earn income by themselves.

The operation of Grameen Bank has also helped women to raise their incomes. This Bank is operating throughout the Project villages and provides loans to an amount of Tk 2000-2500 to groups of poor women. The loans are usually for paddy/rice trading, livestock and poultry rearing. There are also groups of Mahila Samabay Samiti (MSS - Women's Cooperative Society) under BRDB. The MSS group members also get loans for almost the same purposes, which ultimately can add to women's income.

A number of women are involved in road maintenance activities under the Food For Work (FFW) programme and the CARE Road Maintenance Programme. The CARE employees get Tk. 720 a month and FFW workers get 30 seers of wheat in a month. However, neither the Grameen Bank and BRDB, nor the CARE and FFW activities, are the result of the Project. These are only changes over time due to various policy interventions by different organizations. It does not appear that these interventions were facilitated by the Project.

9.5 OVERALL IMPACT ON WOMEN

The overall changes in the Project area affecting women are positive in terms of employment and income. Poor and destitute women can get more work than before the Project since agricultural output has increased on the whole, but the scope of employment is not equal throughout the year. However, there is still potential for these poor women to increase the wellbeing of their families through increased economic activities. At best the Project has contributed marginally but positively to these trends. It appears not to have disbenefited women relative to men.

10 SOCIAL AND INSTITUTIONAL IMPACTS

10.1 PRE-PROJECT SITUATION

The total population of the Project area was about 23027 in 1981 (based on the 1981 census). Most of the inhabitants of the Project area were farmers and they mainly depended on agriculture for their livelihood. About 68 per cent of the family heads were primarily owner farmers and tenant farmers, and 30 per cent were day labourers (Naqi, 1980). The day labourers were mainly landless, small land owners and share croppers. Forty-six per cent of households were poor. Their monthly income per family averaged Tk. 500. The wage rate in the Project area was very low. During the sowing and harvesting periods the wage rate was Tk. 5-12 with food and Tk. 15-20 without food. In the slack season the wage rate was Tk. 3-6 with food and Tk. 10-12 without food. There was a considerable amount of unemployment in the area.

Land ownership distribution was highly skewed in the Project area (Naqi, 1980): 23 per cent of households were absolutely landless, 9 per cent owned less than one acre of land, and 37 per cent owned five acres or more land. The average land holding was three acres.

During the pre-Project period there were no BRDB co-operatives in the Project area. NGO activity in the Project area was also absent. A few co-operative societies were functioning and operating inside the Project area under the supervision of the Cooperative Department.

Social infrastructure such as schools, madrashas, hospitals, roads and transport systems were poorly developed, and the level of literacy was very low.

10.2 PROJECT OBJECTIVES

There was no explicit project objective for initiating and accelerating institutional facilities towards social and economic development. The objective of the Project according to the PP is to protect the crops against floods and to make available sufficient quantity of water for irrigation purposes in the low pockets of the beels during the winter (Planning Commission, 1988; p5). Communication in the Project area was also expected to improve after the implementation of the Project.

One might expect that following increased agricultural production due to flood control and irrigation facilities, rural services such as communication, infrastructure, educational institutions, co-operatives and community services would emerge for the overall development of the Project area.

10.3 WITH PROJECT CONDITIONS

10.3.1 Social Situation

The social situation at present appears to be little different from that before the Project. During the Project period, changes took place with respect to demographic characteristics (increased population), occupation, land ownership and farm size distribution (increased landlessness), and tenurial relationships, but these are part of the changes that are taking

place in the country in general. For example, the density of population in the Project area has increased during the Project period as a part of the national population growth trend.

Group interviews in villages in the Project area indicated that there was a general increase in landlessness in the Project area. Seasonal out-migration of wage labourers from the Project area to other districts increased.

In the present situation about 30 per cent of households are landless. A small distinct affluent class owning about 55-60 per cent of land dominates the social life of the community. The Project appears not to have a major direct distributional impact between households, though it certainly does not favour the rural poor, since the main benefits are to farmers. Agricultural labourers may have somewhat more work than they would otherwise, but the Project impact is dwarfed by that of irrigated Boro cultivation, and there is negligible embankment maintenance to provide regular work. Any non-agricultural flood protection benefit applies to all households, but the Project did not provide security in the 1988 flood, and this probably had proportionately greater damaging impacts on poor households. Most important has been the adverse impact on the professional fishing community (see Chapter 6) and on the access of the poor to fish during the monsoon season, which is directly due to the Project.

During the Project period, a number of institutions such as the BRDB and Grameen Bank have been functioning in the Project area.

10.3.2 BRDB Cooperatives of Sarishabari Upazila

BRDB Co-operatives were observed to function in the Project area. The 1991 position in Sarishabari Upazila, in which much of the Project lies, is presented in Table 10.1.

Table 10.1 BRDB Cooperatives, Sarishabari Upazila

Name of Co-operatives	No. of Societies	Enrolment/ Membership	Savings Tk.	Share Tk.
KSS	170	6124	650617	472398
BSS	40	1040	218060	58920
MSS	14	449	67615	30750
MBSS	34	800	182913	55600

Source: BRDB - Sarishabari

Note: KSS = Krishi Samabay Samity (Farmers' Cooperative Society)
BSS = Bittaheen Samabay Samity (Landless Cooperative Society)
MSS = Mahila Samabay Samity (Women's Cooperative Society)
MBSS = Mahila Bittaheen Samabay Samity (Landless Women's Cooperative Society)

Some of the BRDB co-operatives are functioning properly, while some of the societies were reported to function well below expectation.

The chief function of the farmers' co-operative societies is to promote agricultural output and marketing of agricultural products, and so benefit larger farmers.

Other types of BRDB sponsored co-operatives such as small trading, cattle, poultry. and duck raising, and handicrafts were reported to be quite active.

10.3.3 Traditional Co-operatives

Most of the traditional co-operatives are not operating properly and are facing difficulties in improving their poor condition. Only a few are in good condition.

10.3.4 Other Institutions

The Grameen Bank has been assisting disadvantaged groups in the Project area. This institution was reported to be helping men and women in income generating activities: small trading, poultry raising, cattle rearing, small cottage industries and handicrafts, throughout the Project area (see also Chapter 9).

10.3.5 Other Social and Institutional Changes

Some informal co-operative societies have emerged in the Project area. These co-operatives have no formal registration with BRDB/Co-operative Department. Villagers form these societies at their own initiative. Their activities are limited to saving, credit distribution and agricultural marketing.

Field observations indicate that farmers seldom get a fair price for their agricultural produce. They often have to sell their crops immediately after harvest in order to meet their urgent consumption requirements and some farm expenditures. They cannot hold their produce till the time when better prices prevail in the market. Availability of adequate agricultural credit might help to improve this situation. Provision for adequate institutional credit in the right volume and at the right time will not only help the farming population in financing their farm activities but also enable them to obtain a better price for their products by enabling them to delay sale of produce.

10.4 SOCIAL AND INSTITUTIONAL IMPACT

10.4.1 Positive Impacts

- The embankment has improved road communications. Part is a road-cum-embankment which is used by rickshaw/vans and bullock and horse carts.

- The embankment is a place of shelter in high floods.

- There has been an increase in agricultural employment due to overall cropping changes, which are partly a result of the Project.

10.4.2 Negative Impacts

- The Project and growth in irrigation have not prevented increased seasonal out-migration of wage labourers from the Project area to other Districts.

- Although there has been some development of rural institutions in the Project area this has been part of general trends. The Project has not been used as a focal point for development activities.

- There is no evidence of benefits being targeted at the poor. Although some benefit has accrued to labourers it does not improve their relative position, while a vulnerable group (fishermen) has been adversely affected.

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11 ENVIRONMENTAL EVALUATION

11.1 ENVIRONMENTAL BACKGROUND

The Katakhali Khal Project Area is within Agro-ecological subregion 8b, the lower Brahmaputra Floodplain of the young Brahmaputra and Jamuna Floodplain Agro-ecological region (FAO, 1988). This region has a complex relief of broad and narrow ridges, inter-ridge depressions, partially infilled cut off channels, and basins. The difference in elevation between the tops of ridges and adjoining basins varies from 2 to 5 metres and is least in subregion 8b.

Grey Floodplain soils predominate. They are developed in Brahmaputra alluvium which has mainly been deposited during the period since the river changed into its Jamuna channel about 200 years ago (FAO, 1988).

The soils range from shallow, permeable, sandy loams and silty loams on ridge crests to impervious heavy clays in some basin centres. Organic matter contents are 1 - 2 per cent in most depressions and basins but they are 2-5 per cent in basin centres which stay wet for most or all of the dry season. The soil pH ranges from neutral to slightly acidic in reaction. Basin clays and those soils whose topsoils are puddled for transplanted paddy cultivation are slowly permeable. Moisture holding capacity is very high. Soils are dark grey (FAO, 1988).

In the pre-Project era, it was reported by local people that, during the monsoon, the river Jhinai over-flowed its banks and inundated a large portion of the area, and sudden inflow of river water caused damage to the standing crops (Aus, jute, and B. Aman or late sown T. Aman). The extent of damage would reach up to 80 per cent (reported by local people). Crop damage was severe along the river-side, since much of the inflow of flood water came through Katakhali Khal.

The Project area had several beels, and thus comprised mainly lowland interspersed with higher areas. During the winter, there were substantial uncultivated areas of low land, mainly the perennial water body of beels. These wetlands were a key component of the environment of the Project area. Before the embankment numbers of migrant ducks would visit the Project area.

11.2 PROJECT OBJECTIVES

The primary aims of the Project (preventing more frequent floods from outside the area and reducing monsoon water depths) are clearly environmental in nature. However, in the Project documents there was no explicit discussion of likely environmental impacts of the Project: no discussion of possible changes in morphology and sedimentation; and no discussion of the ecological importance of the area or of likely changes (neither for aspects with direct market implications such as fisheries, nor wider ecological changes).

11.3 SOURCES OF INFORMATION

There being no published environmental information specific to the Project area, and no environmental baseline survey for the Project area, information is limited to that obtained from discussions with local people (farmers, fishermen, local officials), and from personal observation.

11.4 PHYSICAL ENVIRONMENTAL IMPACTS

Physical impacts have been subdivided into water-related and land related (Table 11.1); other physical issues such as climate and atmosphere have not been affected by the Project.

11.4.1 Physical Impacts (Water)

(a) River Flow

The volume, duration, timing and velocity of the Jhinai River seem not to have been significantly affected by the Katakhali Project. During the monsoon this river derives much of its flow from the Jamuna (Brahmaputra), and it seems unlikely that the Project has altered this flow, although it and other embankments along the Jhinai obviously constrict the flow. Internal rain water ponded up in the beels in any case without the Project.

There are no rivers within the Project area; the khals and beels are considered as wetlands and waterbodies in (g) and (h) below.

(b) River Quality

River quality may be affected by the quality of the drainage effluent if this has deteriorated and if significant amounts entered the river. Salinity is not a factor in the Jhinai river and any pollution of the river by agro-chemicals or sewage is highly diluted by the huge monsoon flows.

The important quality concern, therefore, is sand and sediment, which the river carries from the river Jamuna. Although it is claimed that the Project retains locally generated sediment it is unlikely that the total sediment load in the river has changed. Therefore, the turbidity may be much the same. Although there is siltation in the river, this appears not to be related to the Project. Hence no Project impact on external river quality is detected.

(c) River Morphology

Changes in river morphology result from bank erosion, scour and siltation. It is evident from (a) that the Project will not significantly have affected any of these in the Jhinai. Erosion of the northern part of the embankment at Bausi has occurred, but is unlikely to be due to the presence of the embankment.

(d) Flooding

The Project was designed to exclude early monsoon river floods and to pass internal run-off to the Jhinai and so to have a comprehensive beneficial effect on the level, timing, rate of rise, duration and extent of flooding. In practice it appears that the Project has decreased the risk of flooding within the Project area and both the early and monsoon water levels in general have decreased after the Project. However, the Project failed to exclude the peak 1988 flood, and since then has been open in one place, so that the benefit is restricted to floods of more frequent occurrence. A minor positive impact is therefore assumed within the Project. Externally no significant impact on flood levels was noted.

(e) Ground water levels/recharge

This is an important issue because of the rapid spread of shallow tubewell irrigation within the Project area, particularly for HYV Boro. It is not possible to detect any immediate trends because this is a relatively long term phenomenon. Ground water levels should be monitored to identify any trends which could affect the viability of irrigation. Given the proximity of the river and rain water in the beel areas, it is impossible to predict whether ground water recharge has or will be affected by the Project.

(f) Groundwater Quality

Use of agrochemicals has increased to some extent in the Project area, although cowdung is also used for paddy cultivation (Chapter 4). Any contaminated water should ultimately be washed out thorough the breaches, public cuts and regulators. Therefore, the possibility of groundwater contamination is very low, but might be higher if the Project were more effectively maintained.

Monitoring is needed, here as well as elsewhere, to bring the information to a sharper focus.

(g) Wetland and Waterbodies: Extent and Recharge

The Project area had a number of perennial water bodies such as beels (Chapter 6) and lowlying areas. After the Project the beels are mostly dried up and are under cultivation during winter.

Before the Project, flood water flowed into and out of the area. This appeared to result in less sedimentation in the beels. Since the Project, external floods have been kept out, but rain water collects to fill up the beels. The rainfall also washes out soil, particularly from earth roads which have increased in number, and results in sedimentation in the beels since there is no way for silt to be washed out with floods. Consequently beel bed levels are reported to have risen since the Project. Although drainage structures were built, apparently no re-excavation of khals was carried out as part of the Project. Although the structures permit water to drain out, there seems not to have been an improvement in drainage through them (in one case the sluice bed level was reported to be above the land level the farmers wanted it to drain). Where the drainage has been improved this was not as part of the Project. Thus in the early 1980s a canal had reportedly been cut as part of a government sponsored programme to drain out the northern beels in the Project area into the river to the north - the opposite of the BWDB Project. However, this khal is reported to have since silted up.

The Project has created a moderate negative impact within the Project area. These trends are more widespread than the Project area, and the Project's influence also is more widespread. Beel Dublai south-east of the Project was found to drain to the south rather than directly into the Jhinai and is impeded by a small culvert in a CARE road (although the road helps by retaining water for irrigation the farmers want more control to drain out water from heavy rain). This is because the same process of siltation of the beel has occurred, and the flood protection impact of the Project has extended to this beel - before, it received flood water from the north-west (the Project area), which later drained southward. Now external floods (in all but 1988) have been excluded. Consequently even a beel nominally outside the Project has been affected to some extent. This also raises the question as to what extent drying out of the beels would have occurred irrespective of the Project, since wetlands are not permanent features.

(e) Wetland and Waterbodies: Quality

Monsoon surface water quality in the Project area appears to have declined. There is no longer the flushing effect of external flood water. Instead there is drainage congestion due to silting up of khals and in some places there are no proper outlets. As a result rain washed indiscriminate sewage and leached fertilisers and other agrochemicals accumulate in lowlying areas. A particular source of pollution is the retting of jute (a major crop in this area) in standing rather than flowing water. The magnitude of the negative impact could not be assessed. Again real data are required, as throughout most of Bangladesh, to evaluate this trend.

In wetlands downstream no significant impact was noted.

11.4.2 Physical Impact (Land)

(a) Soil Fertility

Because of the change in the extent and depth of flooding (Chapter 4, Table 4.1) soil fertility has possibly been changed. This has reduced the growth of aquatic weeds which support the growth of blue green algae and supplied nitrogen to the soil. Since the Project normal external floods have been kept out, and rainwater washes out soil, particularly from earth roads (which are of low quality) onto the fields. In addition breaches and public cuts have resulted in sand deposition in limited areas. Overall there has probably been a small negative impact inside the Project area.

Outside the Project area there is unlikely to have been any significant impact.

(b) Soil Physical Characteristics

The beels and lowlying areas now dry out seasonally when they were previously flooded. This may have had a small impact in the Project area by improving soil physical characteristics, particularly structure. The most important change is possibly due to the deposition of earth (often fine sand) due to rain erosion. Previously this was washed out by floods. At present, flood water neither flows into nor out of the area, hence sediment is left in the lowlying areas. Breaches and cuts in the embankment have resulted in sand deposition. Overall the reduction in fallow land and increased intensity of cultivation will also have had some effect. In terms of crop suitability soil conditions have probably slightly improved.

(c) Soil moisture status

This has suffered a slight negative impact in the highland areas because of the decreased flooding. The beels have become seasonal and, with irrigation (non-Project impact), soil moisture is now better balanced for crop production. In general soil moisture status has not been changed significantly, and is unlikely to be affected outside the Project.

(d) Soil Erosion

Soil erosion before the construction of the Project was negligible. However, construction of roads has resulted in local soil erosion as discussed for the waterbodies.

(e) Land Capability

The net impact on land capability is a minor positive impact. Previously B. Aman was cultivated but this has now been replaced substantially by T.L. Aman and T. HYV Aman. This has become possible as a result of reduced flooding in the lowlands. This gain might be greater if the originally planned degree of flood control is achieved and proper drainage is maintained. Additionally the area of winter season fallow land has fallen from an average of 50 per cent fallow to 15 per cent fallow. Silting of beels and availability of small scale irrigation are the reasons for this.

(f) Land Availability

There has been a moderate gain in land available seasonally for cultivation - the silting of beels and switch to HYV Boro with irrigation have increased cropping intensity. This is at best indirectly due to the Project since drainage appears not to have been much improved.

Externally no significant impact is noted.

11.5 BIOLOGICAL ENVIRONMENTAL IMPACTS

Biological environmental issues affected by the Katakhali Project can be divided into fauna and flora impacts. Most have suffered no significant impacts but are briefly examined because of the popular awareness of such issues.

11.5.1 Biological Impact (Fauna)

(a) Bird Communities/Habitats

Correlated with the loss of winter beel area there has been a loss of migrant ducks from the area (of ecological note but also a loss of animal protein to local people). This is part of a national trend. Without baseline data it is impossible to say how important this negative impact is, nor what the ornithological interest is of the wet paddy fields which replace the beels.

(b) Fish Communities/Habitats

There has been a general negative impact on the available habitat for fish and hence on fish population and diversity. This is due to the reduction in the flooded area, and to the interruption of spawning and recruitment movements of the major and minor carps and shrimps (Chapter 6, Table 6.3).

The migratory fish species, which are relatively important commercially, have been lost because the beels and lowlying areas have been cut off from the rivers. The fish species which can breed in the beels without migration now suffer from overfishing and the area available to them is reduced.

The only positive impact noted was in culture fishery. The farmers in the relatively high land areas have constructed new ponds, because ponds are protected from overtopping in floods, and to compensate for the lack of capture fish.

Overall a moderate negative impact is assumed in the Project area, and outside the Project no significant impact is noted.

(c) Other Macro-Fauna Communities/Habitats

The same comments apply as for (a) above: already by Project completion in 1983 the intensive occupation and utilization of land had reduced the populations of mammals, reptiles, and amphibians to very low levels. The continued decline during the Project's life has not been significantly accelerated by the Project, in part because it started from too low a base-level.

The lack of historical data for this and most other biological issues in Bangladesh is unfortunate, as it prevents any attempt to plot the decline of the country's wildlife and habitats. This would have enabled the Project's impact on these issues to be shown in a true perspective.

(d) Micro-fauna communities/Habitats

Section 11.4.2 (a) noted that growth of blue-green algae, one of the major microbiota elements in Bangladesh, has been reduced. In the total absence of data, it is assumed that other microbiota are similarly affected by the Project, hence the impact is assumed to be a minor negative one.

In the downstream external areas, micro-fauna in wetlands and rivers are unlikely to have been significantly affected.

11.5.2 Biological Impact (Flora)

(a) Trees

There has been a general decline in the number of trees in the area; in a majority of villages local people reported a 75 per cent decline since 1980. However, this is not related to the Project. Poverty has forced people to sell their mature trees for timber, and population pressure has resulted in clearing of some higher lands for new homesteads. No tree planting due to the reduction in flood risk appears to have been induced.

(b) Other Terrestrial Vegetation

No impact, but there is a lack of data on which to make a proper assessment.

(c) Aquatic Vegetation

The communities and habitats of aquatic vegetation have been reduced due to the reduced area of perennial waterbodies.

11.6 HUMAN ENVIRONMENTAL IMPACTS

Some of the most important environmental impacts of the Katakhali Khal Project are those affecting the human environment. However, many of these issues are covered in other chapters of this report. Here an overview of the impacts is presented in Table 11.4, and they are briefly summarised below:

Human impacts can be conveniently grouped into five sub-categories: human use, social, economic, institutional and cultural.

11.6.1 Human Use Impacts

(a) Crop Cultivation

As shown in Chapter 4, B. Aman has been substantially replaced by T. Aman because of the Project, and this is a moderate positive impact. Cropping intensity has increased slightly. A much greater change has been the growth in HYV Boro cultivation; however, this is more widespread phenomenon and has only marginally been due to the Project. Externally no significant impact is noted.

(b) Livestock

The numbers of poultry have increased, due to increased bran production, which is partly a consequence of the Project. The cattle population has decreased after the Project by about 40-45 per cent. However, this is linked with the reduction of grazing land which is due to increased Boro cultivation.

On an average no Project impact is assumed.

(c) Fisheries

A serious negative impact has occurred, because the beels are now under Boro cultivation and are cut off from the rivers by the embankment. However, fish cultivation is increasingly practised because the ponds are not overtopped.

Externally the impact is uncertain. There will be some cumulative effect on the fish moving through the adjacent rivers. Some external beels are also cut off from annual floods, and fishing pressure on external waterbodies may be increased because of the loss of fish in the Project.

(d) Afforestation

No project impact, but an opportunity to plant the embankment is being missed which would enhance tree cover, provide fuelwood and or fodder, and provide protection against erosion and counteract the decline in tree cover in the area.

(e) Agro-industrial Activities

No significant project impact. An increase in rice mills reflects the success of HYV Boro irrigated by tubewells.

(f) Transport and Communications

The Project structures have improved road communications. Part of the embankment is a road-cum-embankment which is used by rickshaw/vans and bullock and horse carts. In fact it is an upgraded village road.

(g) Domestic Water Supply

The discussion in 11.4.1 (e) indicates the Project's effect on groundwater recharge is negligible. However, it is emphasized that the effect should be demonstrated.

(h) Sanitation

The embankment prevents the flushing of surface water to some extent, therefore, there is some accumulation of sewage which pollutes the lowlying areas and beels. This may create health hazards (Chapter 8).

(i) Recreation

Not affected

(j) Energy

Fossil energy use has increased for groundwater irrigation and the increased number of small rice mills in the Project area, however this is largely a result of HYV Boro cultivation and not the Project.

11.6.2 Social Impacts

(a) Human Carrying Capacity

The increased land capability and land availability have resulted in increased crop production and have caused a slight increase in human carrying capacity (see Section 11.4.2 (e) and (f)). However, negative impacts on capture fisheries and livestock are important. Overall a minor positive impact is assumed.

(b) Demography

The Project itself has probably not significantly influenced demographic structure and trends, except as in (a) above.

(c) Gender

There has been a minor positive impact on the role of women in the Project area, slightly greater employment opportunities have been created because of higher agricultural output than before.

(d) Age

No significant impact

(e) Health and Nutrition

Minor positive impact due to project related increases in crop and vegetable production and consumption.

(f) Disruption, Safety and Survival

The embankment has generated some sense of security, for example in locating new houses. Since the Project has reduced the risk of flooding, disruption is reduced and safety is better than before; a minor positive impact is assumed within the area. However, this may well be a false sense of security - there were serious flood losses in 1988 and currently the Project does not even provide the 1-in-20 year standard of protection intended because it has yet to be repaired.

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(g) Land ownership

Not affected

(h) Equity

There has been no positive impact (see Section 10.3.1). Farmers have achieved some gains, but landless labourers probably have little more work than before, given population growth. What is certain is that traditional fishermen have lost income relative to other groups.

(i) Social Cohesion

Cohesion among socio-economic groups is little changed. However, there is much resentment amongst the traditional fishermen who were adversely affected. Beneficiaries have formed sluice committees, although these are not representative of all the interests affected (farmers of different land levels and fishermen). Local people were mobilised to protect the embankment when it was threatened by overtopping in 1988.

(j) Social Attitudes

The Project did not create any significant impact on social attitudes. There is little difference between the Project and adjacent areas.

11.6.3 Economic Impacts

The three main potential economic impacts of the Project are on incomes, employment and land values. There have been minor positive impacts on the first two, although the relative trend in land values is not clear. Since production has increased it is assumed that land values have also gone up but this is more due to irrigation. The impacts arise primarily from increased cultivation and production. Construction of local roads within the Project has increased facilities for male employment.

Outside the area there are rice mills, jute mills, brickfields and also construction work but these are not related to the Project (Chapter 7).

11.6.4 Institutional Impacts

Institutional activity does not seem to have improved significantly as a result of the Project. The Project has still some way to go to reach its target. The capability to maintain and operate both the flood protection and drainage elements of the Project seems lacking. Consultation between BWDB, the local administration, and the local people over Project planning, operation and maintenance has been virtually non-existent. Overall a minor negative impact is assumed.

11.6.5 Cultural Impacts

It is difficult to see that the Project has significantly affected cultural heritage and continuity or scenic qualities in the Project area. There are no particular historical, archaeological or more recent cultural sites within the area.

However, quality of life has overall improved slightly through improved roads and general well-being of the people.

11.7 ENVIRONMENTAL SCREENING

The primary Project aims were flood protection and drainage. The scoping exercise in Sections 11.4-11.6 shows that neither of these has been fully achieved. Only partial flood protection has been achieved. The threat of catastrophic flooding remains due to cuts and breaches. The drainage system suffers from siltation and poor maintenance, and is also obstructed by earthen roads, and silted up by rain washing of these roads.

The environmental screening of Project activities implicit in Sections 11.4-11.6 shows, therefore, that the most immediate concerns are problems of flood protection and drainage congestion, siltation and loss of fisheries.

11.8 CONCLUSIONS AND RECOMMENDATIONS

11.8.1 Conclusions

The Katakhali Project has had a limited environmental impact. There have been no major and only two moderate positive net impacts in the Project area. Most positive impacts are minor.

The main negative impacts overall have been:

- the decrease in wetlands and consequent decline in the communities and habitats of fish and aquatic micro-biota;
- the decline in capture fisheries; and
- the lack of public participation and the lack of success in achieving institutional effectiveness.

11.8.2 Recommendations

- repair of the cuts, drainage systems and structures to allow the Katakhali Project to function as planned;
- monitoring of physical processes in and outside the Project area (such as river and beel bed levels) would help in understanding the needs of farmers and in assessing the long term environmental impacts of Projects; and
- siltation from rain cutting of earth roads and embankments is a problem. Establishment of trees and ground cover plants on a trial basis along earthworks could ultimately help to reduce soil erosion.

Table 11.1 Physical Environmental Impacts.

Physical Issues	Degree of Environmental Impact	
	Project Area Impacts	External Impacts
WATER		
a. River Flow	-	0
b. River Quality	-	0
c. River Morphology	-	0
d. Flooding	+1	0
e. Groundwater Levels/Recharge	0	0
f. Groundwater Quality	0	0
g. Wetlands and Waterbodies Extent/Recharge	-2	-1
h. Wetlands and Waterbodies Quality	-1	0
LAND		
a. Soil Fertility	-1	0
b. Soil Physical Characteristics	-1	0
c. Soil Moisture Status	0	0
d. Soil Erosion	0	0
e. Land Capability	+1	0
f. Land Availability	+2	+1

Table 11.2 Biological Environmental Impacts

Biological Issues	Degree of Environmental Impact	
	Project Area Impacts	External Impacts
FAUNA		
a. Bird Communities/Habitats	-1	0
b. Fish Communities/Habitats	-2	0
c. Other Macro-Fauna Communities/Habitats	0	0
d. Micro-Fauna Communities/Habitats	-1	0
FLORA		
a. Trees	0	0
b. Other Terrestrial Vegetation	0	0
c. Aquatic Vegetation	-1	0

Table 11.3 Human Environmental Impacts

Human Issues	Degree of Environmental Impact	
	Project Area Impacts	External Impacts
HUMAN USE		
a. Crop Cultivation	+2	0
b. Livestock	0	0
c. Fisheries	-2	0
d. Afforestation	0	0
e. Agro-industrial	0	0
f. Transport Communications	+1	0
g. Domestic Water Supply	0	0
h. Sanitation	0	0
i. Recreation	0	0
j. Energy	0	0
SOCIAL		
a. Human Carrying Capacity	+1	0
b. Demography	0	0
c. Gender	+1	0
d. Age	0	0
e. Health and Nutrition	+1	0
f. Disruption, Safety and Survival	+1	0
g. Land Ownership	0	0
h. Equity	-1	0
i. Social Cohesion	0	0
j. Social Attitudes	0	0
ECONOMIC		
a. Incomes	+1	0
b. Employment	+1	0
c. Land Values	+1	0
d. Credit Availability	0	0
INSTITUTIONAL		
a. Institutional Activity/Effectiveness	-1	0
b. Public Participation	-1	0
CULTURAL		
a. Historical/Archaeological Sites	0	0
b. Cultural Continuity	0	0
c. Aesthetics	0	0
d. Lifestyle (Quality of life)	+1	0

12. OVERALL ECONOMIC ASSESSMENT

12.1 PREVIOUS APPRAISAL

Katakhali Khal Project is relatively well documented and both the EIP recommendation (EIP, 1980) and the revised PP (Planning Commission, 1988) give details of a benefit-cost appraisal. In both cases the only benefits attributed were from changes in monsoon season cropping patterns and increased yields (to reflect reduction in flood damages). EIP (1980) estimated an incremental benefit of Tk 3.39 million a year and an annual cost of Tk 1.25 million, giving a benefit-cost ratio of 2.7. The social performance was anticipated to be desirable but with the benefits biased to middle and larger farmers. However, middle sized holdings were reportedly not in surplus (although no evidence was available).

Planning Commission (1988) is more explicit in its benefit-cost assessment. It estimated a financial internal rate of return of 16%, with a NPV of Tk 1.06 million at a 15 per cent discount rate in 1983 prices. The economic assessment gave a rate of return of 27 per cent and a NPV of Tk 10.0 million in 1983 prices. This was not, however, a post-evaluation of the project (despite the suitably long period between completion and reporting) but was effectively a project completion report giving actual costs and repeating the predicted benefits without the benefit of a study of the actual impacts. The benefit cost assessment was based on estimated net incremental agricultural benefits of Tk 2.38 million (financial) and Tk 3.58 million (economic) in 1983 prices. These represented respectively a 33 per cent and a 34 per cent increase in the net returns from agriculture attributed to the Project.

No mention was made of any impacts other than on cultivation.

12.2 PROJECT COSTS

12.2.1 Construction costs

The financial costs of the project have been clearly stated in the revised PP (Planning Commission, 1988), and this Project is notable for the high quality of project documentation, compared with other projects where RRAs were undertaken. Table 12.1 summarises this information. While the revised PP explains that three box sluices instead of the planned two were built, it provides no justification for this change in the project planning. Moreover it consistently refers to the Katakhali Khal regulator having four gates when in fact it has three gates. The PCR (BWDB, 1986) also refers to four vents, and also still refers to there only being two box sluices, the overall impression being of an accounting exercise without anyone actually checking up on what had in fact been built.

The revised PP notes that the overall cost overrun amounted to 13 per cent of the original estimated costs. However, the breakdown of project costs is more revealing. The main regulator cost only one per cent more than estimated, but the one vent regulator at Taltala cost 53 per cent more, and the box sluices 689 per cent of the original estimate at a total of Tk 2.07 million, compared with Tk 2.03 million for the main regulator. Although these box sluices help drainage, their command areas are very localised (since higher land prevents drainage of the south-eastern parts of the project influenced area towards the Jhinai river), and they were installed in the earth road which was used as part of the embankment (to save land acquisition costs and rationalise on earthworks). The relative price for the areas commanded is high for the box sluices, while nothing was spent on khal excavation so that drainage improvements were small.

Using the conversion factors for project costs recommended by FPCO (1991), and updating to 1991 prices using the construction cost index (BBS, 1990) from 1983 prices to 1989 prices and thereafter assuming a 10 per cent inflation rate gives economic construction costs, excluding land acquisition, of Tk 2.29 million in 1980/81, Tk 6.42 million in 1981/82 and Tk 1.88 million in 1982/82. Land acquisition costs are best treated as a loss of annual agricultural gross margins since this represents the opportunity cost of the land during the lifetime of the project, after which it could be made free for other uses. The equivalent financial costs including land acquisition are Tk 5.8 million, Tk 10.23 million, and Tk 2.99 million respectively. Hence the total financial costs were Tk 19.02 million (1991 prices) or Tk 7457 per cultivable ha, while the total economic cost was Tk 10.59 million (1991 prices) or Tk 4202 per cultivable ha.

12.2.2 Operation and maintenance costs

In the revised PP (Planning Commission, 1988) it was estimated that operation and maintenance (O&M) would require each year: one full time SAE, WA and khalashi, and two peons, plus 320 gallons of petrol, 1.25 tons of cement and 10,000 bricks. Additionally unspecified overheads of Tk 4000, maintenance costs of Tk 66,000 and contingencies of Tk 25,000 (all in 1983 prices) were noted. It is unclear what these materials would have been used for as no justification is given for the estimates. However, it is clear that the actual O&M of the project has been negligible since its completion, and this should have been known at the time of preparing the revised PP.

For the post-evaluation the Project impacts reflect the actual level of O&M of the project, and hence it is inappropriate to use the intended figures. There are no staff specifically appointed to the project (the structures are operated, infrequently, by local committees), there is nothing to require fuel, no materials have been used to repair the structures, and no earthwork has been done to maintain or rehabilitate the embankment (Chapter 2 shows that breaches remain open since 1988). Hence a realistic assumption is zero O&M expenditure and associated with this lower agricultural benefits to reflect the flood risk. The alternative is to assume the normal average O&M expenditure. From the other RRAs carried out this averages Tk 270 per ha in 1991 financial prices, or about Tk 200 per ha in economic prices - amounting to Tk 0.5 million a year for Katakhali Khal Project.

12.3 PROJECT IMPACTS

12.3.1 Summary

Chapters 4-11 have detailed the impacts of the Project. These include important negative environmental impacts, which cannot be assessed in economic terms or even quantified accurately for want of baseline data, and some diffuse secondary impacts on the local economy and pattern of income distribution. In this section the aggregate impacts of the Project are assessed for agriculture and fisheries - the main components for which economic impacts can be estimated. It is important to note that these estimates are based on the RRA results and secondary source information, and hence their reliability cannot be assessed. The assumptions necessary in making this indicative post-project appraisal are often considerable.

12.3.2 Agricultural Impact

Chapter 4 noted that there had been considerable changes in cropping pattern, and to a small extent in yields, since the project. Overall since the Project paddy production has

increased by about 11000 mt, but of this about 2150 mt are in the Aman season, due to switches from B Aman to TL Aman and from TL Aman to HYV Aman.

The financial and economic returns per ha to the main crops have been estimated (Table 12.2) based where possible on data presented in Chapter 4. The labour and fertiliser input data obtained in the RRA have been used, supplemented by data from the north-east in MPO (1987) where the RRA did not obtain data. Seed requirements are taken from MPO (1987), except that because the potato yields reported in the Project are only 50 per cent of those in MPO (1987) only 50 per cent of the seed requirement is assumed. In general draft power inputs appear to be low in the area: a cost of Tk 910 per ha per ploughing and minimum of two tillages was assumed for most crops. Irrigation charges were reported to be about Tk 2470 per ha from STWs in the Project area, and this is shadow priced with a SCF of 0.63 (assuming 50 per cent of costs are diesel and 50 per cent unskilled labour). All other prices are taken from FPCO (1991) updated from 1987/88 prices by 10 per cent per annum for local inflation. The exceptions are for labour, where the wage rate reported in the Project area (Tk 22 per day) is used, and for chillies where the price obtained from Chalan Beel area in the PIE is used.

It is clear that the returns from HYV paddy crops are high. Overall, for the cropping patterns established in Chapter 4, it is estimated that aggregate financial gross margins in the Project have increased by Tk 26.2 million a year (Tk 10,400 per cultivable ha), and economic gross margins by Tk 27.8 million a year (Tk 11,040 per cultivable ha), see Table 12.3. However, this is not all due to the Project. It is debatable whether any benefit to HYV Boro can be attributed to the Project. This depends on the extent to which the increase in cultivated area during the winter is due to drainage of the beels or their siltation, and whether this is a result of the Project. Given the general increase in groundwater irrigation and that khals in the Project have not been re-excavated, it is conservative to assume that the Boro/winter crop changes would have happened without the Project. In this case the changes in Aus and jute areas would have happened in any case since these crops could not be grown once HYV Boro was grown. Hence only the changes in the Aman season are attributed to the Project.

The annual increment in financial gross margins for Aman crops is estimated at about Tk 11.4 million (Tk 4536 per cultivated ha), and in economic prices Tk 10.3 million a year (Tk 4081 per ha). However, since the cost of land acquisition has not been included in the project costs the lost opportunity due to the embankment must be allowed for in the agricultural benefit flow. Twenty five ha. of land were acquired and it is assumed that this was medium land (adjacent to Jhinai river). Hence the cultivable land in pre-Project conditions should be 25 ha. more. The implication for the net benefit to agriculture is a financial net benefit of Tk 11.04 million a year, and an economic net benefit of Tk 9.89 million a year.

Unlike the growth in irrigation which must have taken several years, it is likely that the change in cropping pattern in the Aman season happened soon after the Project was completed. A linear increment over the three seasons 1983 to 1985 is assumed. In addition there was no benefit in 1988 when the Project area was flooded. Had the embankment been repaired then the frequency of such losses might have been 1-in-20 years as planned, but given the current state of repair of the embankment it is likely that serious damage to crops due to external flooding, which is not allowed for in the yield estimates used, will occur perhaps once in 5-10 years.

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12.3.3 Fisheries Impact

Chapter 6 showed that there had been a serious negative impact on capture fisheries in the Project area. Although the fishery outside the Project has also declined, the area of the Project floodplain relative to other floodplains in the area was small. Hence it is assumed that external changes cannot be attributed solely to this Project although it will have had some effect, as will overfishing induced by the loss of floodplain fisheries.

Table 6.4 offers one way of estimating the fisheries impact. Birtara Union is almost exactly the same area as the Project, and half of the Project lies within this Union. If it is assumed that there were 30 fishermen in the Project before and now only 15, and that before their catch was 7 kg. per day, but now it is only 0.75 kg. per day (Section 6.5), and that there are 300 fishing days per year, then the pre-Project catch would have been 63 mt. a year, and the post-Project catch is 3.4 mt. a year. However, the area of beels in the Project is greater in the northern half which is outside Birtara Union, and an area based estimate of the fisheries impact may be preferable.

Table 4.1 showed that in pre-Project conditions high land could not be categorised as floodplain, and that even on medium land water levels were relatively shallow. Hence it is assumed that only the low land contributed significantly to the floodplain fish stock, this simplification will tend to underestimate any negative impact. Out of the 696 ha of low land only 58 per cent was cultivated in the pre-Project period, the remainder being too wet even for L Boro. A conservative assumption is that half of the remaining area was then beels, while a pessimistic assumption (for the Project) is that all of this area was at that time beels. The remainder of the low land was a floodplain fishery. With the Project all of this land is cultivated in the dry season, but in the monsoon season it still has relatively deep water on it and so is assumed to be floodplain - but isolated from the main river system.

The standard FAP 12 value assumptions for capture fish production are: Tk 55 per kg 1991 market price of fish, 10 Tk/kg depreciation of equipment, and Tk 30/kg labour costs, assuming a 1.0 SCF for fish, and 0.71 SCF for equipment and labour, this gives a net value of fish of Tk 15 (financial prices) and Tk 26.6 (economic prices). It is further assumed that in the low intensity fish cultivation practised in Katakhali Khal Project fish production costs are the same as for capture fisheries.

Table 12.4 shows that on the conservative estimate of pre-Project beel area the loss of capture fish is estimated at 68.42 mt a year, with a financial value of Tk 1.04 million, and an economic value of Tk 1.82 million. If all the non-cultivated lowland in winter was beels then the loss is 121.37 mt a year, with a financial value of Tk 1.85 million and economic value of Tk 3.23 million. Against this there has been a rapid growth in pond fish cultivation, but this still contributes a very small total output: 7.5 mt increase in production due to the Project with a value of Tk 0.11 million (financial) and Tk 0.2 million (economic prices).

12.3.4 Other benefits

No benefit from protecting property and infrastructure from flooding has been allowed for, since damages in frequent floods are unlikely to be large, and in severe floods the Project does not prevent damage. This is an oversimplification, and there may be some benefit, but since there are openings in the embankment at present the Project can only be considered effective at reducing normal flooding.

12.4 ECONOMIC POST-PROJECT APPRAISAL

A number of alternative scenarios are possible for the assessment because of the number of assumptions necessary in the previous sections. Table 12.5 gives a discounted cash flow for how the Project should have worked: assuming that O&M was carried out as planned, and hence that there is no loss to crops in the Project due to floods, and that all the non-cultivated lowlands were beel areas. This gives an EIRR of 31%. Table 12.6 compares the results of different combinations of assumptions. Even when the actual circumstances are modelled (no O&M and a total crop failure in 1988 followed by a 1-in-5 risk of complete failure due to the breaches remaining open in all subsequent years) the EIRR is still 27 per cent. The benefit estimate is relatively insensitive to Aman yields (the source of the agricultural benefits). Even a 20 per cent reduction in estimated Aman yields results in only a 32 per cent reduction in the BCR. The fisheries disbenefits may have been overestimated in these scenarios. If they are reduced by assuming that only half of the non-cultivated lowland had been beels then the EIRR rises to 37 per cent.

Overall Katakhali Khal appears to have been in economic terms a successful project, showing a robust and worthwhile economic rate of return. This reflects relatively low construction costs. Even though there were cost overruns and delays in construction these were not excessive. The original project appraisal revealed modest aims - limited to changing Aus and Aman cropping patterns and yields, and estimated a remarkably similar rate of return (EIRR of 27 per cent) to that calculated in the post-appraisal. In the event no benefits to Aus occurred because this crop was replaced by HYV Boro (this has not been counted as a Project benefit, although it is quite possible that some of the area under HYV Boro is due to Project drainage. Otherwise the loss of beel fisheries to cultivation should not be attributed to the Project as a loss). However, there have been important changes due to the Project - B Aman has disappeared and HYV Aman now covers a substantial part of the Project area. This was a benefit which was not predicted in the project appraisal (which depended on changes from B Aman to TL Aman).

Even so the capture fishery in the Project area has been decimated, and some growth in fish cultivation has not compensated for this. The present fish catch is only some 17 per cent of the pre-Project catch. Although the fishery was important it was relatively small, and employed relatively few people. Hence it is easily outweighed by the agricultural benefit. In addition there is some hope that the seasonal floodplain fishery which persists in the Project could be managed with releases of fingerlings into the temporary beels. However, this will require a transfer from a common access resource to seasonal ownership of fishing rights by cooperatives of fishermen.

The post-project appraisal also indicates that although there are substantial benefits even from the project in its current (1991) condition, there would be a higher rate of return from increased O&M expenditure if this can reduce the risk of crop losses. This potential benefit may have been underestimated for two reasons. No non-agricultural flood damages have been allowed for, yet it is known that there were important flood damages in 1988. Also the years after 1988 do not appear to have been unusual flood years in the area, and so the risk of loss may be higher than 1-in-5 years. Moreover drainage congestion may result in some losses each year which are not allowed for in the yields used in the assessment.

Table 12.1 Financial Cost of Construction of Katakhali Khal Project (Tk 000 in 1983 prices)

Category	1980-81	1981-82	1982-83	Total	Original estimate
Land acquisition	1313	739	191	2243	2950
Earthwork	0	1259	207	1466	1300
Cross dam and drainage channels				0	190
Structures[1]					
cement	141	392	127		
steel rods	186	518	167		
bricks	12	36	12		
sand	4	12	4		
unskilled labour	861	1137	574		
skilled labour	161	450	147		
managerial	54	149	49		
Construction total	1419	3953	1289	5156	3100
Tools and plant	18	0	0	6661	
Establishment				18	0
SDE	18	18	2.6		
SAE	12	12	1.8		
Surveyor	6	6	0.9		
WA	18	18	3		
Peon	7	7	1		
Guard	7	7	1		
Total	68	68	10	146[2]	0
Project overhead	67	350	0	417[2]	390
Headquarters overhead	0	20	0	20	200
Contingency	0	0	0	0	230
Total	2885	5130	1490	9505	8360

Notes: 1 In the comparison of original and actual costs in Planning Commission (1988) this is broken down by structures, see text for discussion.

2 In the PCR (BWDB, 1986) this is broken down Tk 387,000 project overhead (8%) and Tk 176,000 contingency (5%).

Source: Recast PP (Planning Commission, 1988)

Table 12.2 Gross Margins per hectare for Major Crops in Katakhali Khal

crop	gross margins financial pre	post	gross margins economic pre	post
HYV Boro	0	29013	0	28049
L Boro	20831	0	20706	0
Wheat	0	7603	0	7718
Oilseed	10019	9193	9105	8345
Pulses	20499	0	19113	0
Potatoes	986	9924	1643	9866
Chillies	2716	2716	3791	3791
B Aus	7825	12294	8259	12593
B Aus+Aman	13263	0	13764	0
Jute	26520	22302	21861	18402
B Aman	10453	0	10570	0
TL Aman	17189	19908	16867	19504
HYV Aman	0	27433	0	26126

Source: consultant's estimates

Table 12.3 Project Aggregate Gross Margins from Major Crops

crop	financial gm for project 1982/83	1991	economic gm for project 1982/83	1991
HYV Boro	0	62870694	0	60782677
L Boro	6290911	0	6253327	0
Wheat	0	577798	0	586570
Oilseed	1512895	459652	1374926	417271
Pulses	14471972	0	13493820	0
Potatoes	7884	79393	13140	78929
Chillies	206416	0	288101	0
B Aus	4335325	614700	4575448	629669
B Aus+Aman	4005374	0	4156723	0
Jute	28058637	5062508	23129022	4177205
B Aman	2111498	0	2135067	0
TL Aman	19922160	16045559	19549065	15720363
HYV Aman	0	21425417	0	20404387
Total	80923071	107135722	74968640	102797073
Total increment		26212650		27828433
Aman increment		11431944		10283896

Source: consultant's estimates

Table 12.4 Calculation of Fisheries Impacts

Fishery	Pre-Project area ha	yield kg/ha	output mt	Post Project area ha	yield kg/ha	output mt	Difference in output mt	Value of change Financial Tk mill	Economic Tk mill
a) assuming all non-cultivated area of low land was beel									
Beel									
lost	292	400	116.8	0	0	0	-116.8	-1.75	-3.11
remaining	10	400	4.0	10	250	2.5	-1.5	-0.03	-0.04
Floodplain	404	37	14.9	696	17	11.83	-3.07	-0.05	-0.08
b) assuming 50% of non-cultivated low land was beel									
Beel									
lost	146	400	58.4	0	0	0	-58.4	-0.88	-1.55
remaining	10	400	4.0	10	250	2.5	-1.5	-0.03	-0.04
Floodplain	550	37	20.35	696	17	11.83	-8.52	-0.13	-0.23
c) Pond cultivation									
ponds	1.95	500	0.95	17	500	8.5	7.5	0.11	0.20

Source: see Section 12.3.3 for assumptions and data on Katakhali Khal, productivity and net value of output from FAP 12 standard data assumptions.

Table 12.5 Discounted Cash Flow for Katakhali Khal Project Assuming O&M and no Flood Damages

1991 ECONOMIC VALUES IN TK MILLIONS
NO FLOOD DAMAGE, HYPOTHETICAL O&M AND HIGH FISH LOSS ESTIMATE

DATE	CONSTRUCT COST	MAINT COST	FISH BENEFIT	AGRIC BENEFIT	PV COST	PV BEN	BEN-COST
1981	2.29	0	0	0	2.29	.00	-2.29
1982	6.42	0	0	0	5.73	.00	-6.42
1983	1.88	0	0	0	1.50	.00	-1.88
1984	0	.5	-3:03	3.30	.36	.19	-.23
1985	0	.5	-3.03	6.59	.32	2.26	3.06
1986	0	.5	-3.03	9.89	.28	3.89	6.36
1987	0	.5	-3.03	10.28	.25	3.67	6.75
1988	0	.5	-3.03	10.28	.23	3.28	6.75
1989	0	.5	-3.03	10.28	.20	2.93	6.75
1990	0	.5	-3.03	10.28	.18	2.61	6.75
1991	0	.5	-3.03	10.28	.16	2.33	6.75
1992	0	.5	-3.03	10.28	.14	2.08	6.75
1993	0	.5	-3.03	10.28	.13	1.86	6.75
1994	0	.5	-3.03	10.28	.11	1.66	6.75
1995	0	.5	-3.03	10.28	.10	1.48	6.75
1996	0	.5	-3.03	10.28	.09	1.32	6.75
1997	0	.5	-3.03	10.28	.08	1.18	6.75
1998	0	.5	-3.03	10.28	.07	1.06	6.75
1999	0	.5	-3.03	10.28	.07	.94	6.75
2000	0	.5	-3.03	10.28	.06	.84	6.75
2001	0	.5	-3.03	10.28	.05	.75	6.75
2002	0	.5	-3.03	10.28	.05	.67	6.75
2003	0	.5	-3.03	10.28	.04	.60	6.75
2004	0	.5	-3.03	10.28	.04	.53	6.75
2005	0	.5	-3.03	10.28	.03	.48	6.75
2006	0	.5	-3.03	10.28	.03	.43	6.75
2007	0	.5	-3.03	10.28	.03	.38	6.75
2008	0	.5	-3.03	10.28	.02	.34	6.75
2009	0	.5	-3.03	10.28	.02	.30	6.75
2010	0	.5	-3.03	10.28	.02	.27	6.75
TOTAL					12.69	38.37	
					EIRR		31%
					BCR @ 12%		3.02
					NPV Tk m		25.68

SOURCE: Consultants' estimates

Table 12.6 Comparison of Economic Performance Indicators

Project scenario		ERR	BCR @ 12%	NPV @12% Tk mill
1	High fishery loss O&M, no flood damages	31%	3.02	25.68
2	High fishery loss O&M, 1-in-10 100% flood loss	28%	2.60	20.36
3	High fishery loss no O&M 1-in-10 100% flood loss	30%	3.47	23.53
4	High fishery loss no O&M 1988 flood, thereafter 1-in-5 100% loss	27%	2.85	17.57
5	10% less Aman yields than scenario 1	28%	2.57	19.90
6	20% less Aman yields than scenario 1	23%	2.07	13.63
7	Low fishery losses O&M no flood losses	37%	3.77	35.09

Source: Consultant's estimates, see text and Tables 12.1-12.5 for methods and assumptions.

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