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

PROJECT IMPACT EVALUATION OF CHALAN BEEL POLDER - D

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Hunting Technical Services Limited

in association with

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

The full series comprises the following reports:

FAP 12

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

Project Impact Evaluation studies of:

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

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FAP 13

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

[1] Revised versions of these reports were issued in December 1991.

Chalan Beel Polder 'D'

Project Summary Sheet

Project Name	: Chalan Beel Polder 'D'
Project Type	: Flood Control, Drainage and Irrigation
Location	
FAP Region	: North-West
District	: Rajshahi and Noagoan
Area (ha.)	: 53 000 ha. (gross) 37 235 ha. (cultivable)
Funding Agency	: IDA
Implementing Agency	: BWDB
Construction started	: FY 1981/82
Scheduled Completion	: FY
Actual Completion	: FY 1988/89
Original Cost Estimate	: Tk. 285 million
Final Cost Estimate	: Tk. 342.4 million (1991 prices)
Major Flood Damage:	: 1987, 1988
Repair/rehabilitation in	: 1990 to present

CHALAN BEEL POLDER 'D'

SUMMARY OF FINDINGS

Location

Chalan Beel Polder D is located in Rajshahi and Naogaon Districts in the north west of Bangladesh, and falls within the FAP North-West region. The polder is enclosed by the River Atrai and its distributary, the River Fakirni on the east, by the Sib River on the west, and by the Barnai River on the south (see Figure 1.1). The Project covers an area of over 53000 ha. and is relatively flat. It has a complex relief, with undulating highlands, particularly in the northern part, saucer shaped low-lying areas and a number of beels and depressions. The control area is part of the incomplete Barnai Project (see Figure 1.2), since there are no unprotected areas in this part of the Atrai Basin which are not either impacted by completed projects or part of ongoing ones.

Project Objectives

Prior to the Project more than half of the area used to be subject to annual flooding up to 1.5 m in depth. A further quarter of the area used to be flooded annually up to 0.9 m in depth. The Project as implemented was intended as a low-cost, quick-yielding and technically simple FCD project aimed particularly at reducing flooding problems in the shallow to medium flooded areas. The Project involved construction of a 132 km. ring embankment, 17 regulators, 77 dual purpose irrigation inlets/drainage outlets, 8 flushing sluices/drainage outlets, the excavation of 137 km. of drainage channels and construction of 102 km. of main and village roads.

Project History

The Project was first conceived in 1964, as part of an EPWAPDA Master Plan for the Chalan Beel Area and all of what became Bangladesh. In 1970 a feasibility study for the entire area was prepared, and it was proposed to divide the area into four independent polders (A,B,C,D). Polders A,B and C were subsequently implemented and in 1979 a feasibility study was prepared for Chalan Beel Polder D. The World Bank agreed to support the Project under the Second Drainage and Flood Control Project (DFC-II, IDA credit 1184-BD). Construction started in 1981/82 and was completed in 1988/89.

The Project has been the subject of two previous evaluations, one at the time of Project completion (BETS, 1988) and the second two years later (MPO, 1991).

Construction and Design

The Project went through a series of designs. The 1979 feasibility study proposed pumped drainage, but this was subsequently rejected. The number of structures proposed was increased during the construction period. However it appears that the capacity of many of the drainage structures remains inadequate. The quality of construction generally appears to have been good.

Hydrological Impact

Based on the areas of plots cultivated by sample households, the FCD infrastructure has had a limited impact in transforming land to shallower normal flood levels (increase of 17 per cent of protected area); associated with this is a similar reduction in normal inundation period. However, in the unprotected impacted area the area of shallow flooded land has decreased and inundation periods have increased. Thus, there has been a negative off-site impact. The control area showed no significant changes in normal flooding, implying that changes in the impacted area are a Project effect. The adverse impacts are attributed in part to the inadequate drainage structures provided at both ends of the active channel (Kompo River) which passes through the middle of the Project, connecting the Sib and Fakirni Rivers. This has led to increased flood depths in adjacent unprotected areas and has exacerbated drainage congestion inside the Project. The Project has also increased flooding problems downstream.

Unfortunately the Project has also suffered from regular breaches and public cuts, sometimes due to embankment failure during high floods, but mainly due to the conflicting interests of insiders and outsiders, and of farmers and fishermen. These cuts have been followed by sudden rapid inundation of supposedly protected areas and have caused intense dissatisfaction. There have also been substantial drainage congestion problems in some areas of the Project, possibly due to inadequate capacity of drainage structures, and in some cases this has been the cause of the public cuts.

Although irrigation plays a vital role in the rabi season, particularly for HYV Boro cultivation, the incidence of 'modern' irrigation is less in the Project than in the control area. The main irrigation source in the Project is indigenous methods (47 per cent of irrigated area) while in the control area 64 per cent of irrigated land is covered by STWs. However, there is evidence that since the Project, irrigation facilities have been catching up with the control area.

Operation and Maintenance

BWDB spends considerable sums on O&M at Chalan Beel Polder D, but in 1991 it was nevertheless judged that 40 per cent of the embankment length was damaged and in need of repair or rehabilitation. A large portion of the brick mattressing failed within one year, possibly due to poor toe construction. Irrigation inlets were generally in good condition, but some of the drainage structures were in need of repair. An O&M manual had been produced for the Project, but was not in use.

BWDB has not involved local people in operation of Project structures, and local committees have not been formed, but in practice local influential people often control the operation of structures.

There have been numerous disputes over operational procedures, leading on some occasions to the public cuts referred to. The greatest conflict of interest occurs during high floods on the Sib River in the west, when outsiders become desperate and cut the embankment to escape from inundation, causing an annual inflow of water which leads to a chain of cuts in main and village roads down the polder. This eventually leads to public cuts on the eastern side by insiders letting the water out to the Fakirni River, which in turn affects Chalan Beel Polder C.

Agricultural Impact

The Project was expected to lead to a very substantial increase in cropping intensity (eventually to 235 per cent) and to reduce crop losses and increase yields. In practice much of the Project area, and the control area, is monocropped. The most important crop is HYV Boro, which is cultivated to a greater extent in the control area and has been stimulated by expansion in groundwater irrigation, and not by the FCD infrastructure.

Overall paddy yields were slightly higher in the Project area in the survey year, but there is reason to doubt that this is the usual situation. TL Aman and T Aus yields in particular were higher in the protected area, though in the peak flood years of 1987 and 1988 Aus and Aman yields were less than in the control area.

Overall there is a slight positive Project impact on agriculture, but it is far smaller than was anticipated by the Project Feasibility Study.

Livestock Impact

A comparison between livestock holdings in the protected area and in the control area reveals little evidence of Project impact. There are however significantly larger holdings of bovine animals and poultry in the Project area, and incomes from livestock are slightly higher.

Fisheries Impact

In Chalan Beel the polder has led to a reduction in the number of fishermen, a fall in the number of days a year the remaining fishermen spend fishing, and in a fall in their daily catch. As a result production of all capture fish species has dropped. This has been caused by the reduced area annually flooded, by the drying up of beels and the blockage to normal fish migration routes, although general overfishing, fish disease and illegal fishing (non-Project causes) have also contributed to the decline in output. A comparison of the Project and control areas noted that far fewer of the non-farm households in the Project area owned fishing nets, an independent confirmation of impact on capture fishing.

The area has the largest number and area of fishponds of any of the projects studied in detail, but a high proportion of these are still vulnerable to flooding, and their productivity is low - about half that normally expected. As a result increased fishpond output following protection is very limited, perhaps 430 mt. a year, compared to an annual loss of capture fisheries which is estimated to be between 1900 and 2500 mt..

Infrastructure and Communications

The internal road network built by the Project, and the embankment itself, have had a very substantial impact on communications, which is only partly offset by the reduced use of boat transport. However, with the recent advent of powered boats using STW engines, boatmen in the Project area have largely been able to relocate to adjacent areas; the numbers of boatmen in the impacted but unprotected area have increased, while they have decreased in both the protected and control areas.

Few households in the control area appear to have suffered recent damaging flooding (since 1987) whereas 25 per cent of households in the Project area have been flooded in 1988 or later. The Project appears not to have reduced the risk of damaging floods (affecting property) and in 1988 those properties affected in the control area suffered less damage than inside the polder. This may be because households and entrepreneurs felt safe in building inside the Project area on low lands which were considered risky outside.

Socio-Economic Impact

A comparison of social and economic conditions in the Project and control areas suggests that the FCD protection has had a modest positive impact. There has been no change in occupational structure, and agricultural labourers in the Project area report the same rate of employment and the same seasonal pattern (with a slack period in the late monsoon) as those in the control area. Wage rates are the same, and food availability appears to be the same in both areas; about 60 per cent of households reported 'partial starvation' in the lean period.

However, there is a higher level of rice milling and trading, of agricultural input trading and of blacksmithing in the impacted area. There has clearly been substantial employment generation in construction and maintenance of Project earthworks, and this has benefited women as well as men. Women have also benefited from increased work in processing crops as a result of higher production levels, though it is noticeable here, as in many other areas studied, that the growth in irrigation using STWs has been accompanied by use of the STW engines for rice husking, transferring part of the responsibility for this task from women to men. The change in cropping pattern from B Aman to T Aman has benefited women from ethnic minorities who are traditionally hired for transplanting. With the spread of STW engines as boat power units, boatbuilding has also flourished in and around the Project area, though the linkage with the Project in this case is rather tenuous.

Overall, income per capita does not differ between impacted and control areas, but inside the Project incomes appear to be higher for large landowners and lower for landless households and marginal farmers (operating under 1 acre), implying that any distributional impact has been neutral or negative. No notable differences were found in the sources of household income, although crafts are relatively important for middle landholding categories.

Inequality in landholding categories is slightly higher in the Project sample households. Similar proportions of households have changed their holding size in the impacted and control areas, although within the Project the number making a significant shift of holding category (in either direction) is slightly greater. Land acquisition for the Project did not appear to be unusually contentious, but 9 per cent of impacted households lost land in the impacted area, and 5 per cent of acquired land was not compensated for. Since the Project land prices for irrigated and non-irrigated land have been increasing faster in the Project than in the control area, implying a perceived benefit to the Project.

The lack of apparent impacts is also reflected in the lack of difference in quality of life indicators: water and sanitation facilities show no difference between impacted and control area, and there is no difference in the type and quality of housing. More repairs had been carried out in the impacted area, but this reflects flood damage. There is, however, higher literacy amongst household heads in the Project area than in the control area.

People in over half the impacted villages reported having doubts about the necessity for the Project and are dissatisfied with it.

Environmental Evaluation

The potential positive impacts of the Project on human and physical environmental issues, in increasing land availability, monsoon season cropping and harvested monsoon season yields, and in improving the communications network, were limited and have been further offset by a number of serious negative impacts, mainly associated within the impacted area with the annual public cuts and breaches. The main negative impacts are the decrease in wetlands leading to a decline in capture fisheries, the marked deterioration in social cohesion and equity, the failure to develop any public participation in Project operation and the threat to the cultural traditions of the largely Hindu capture fishermen. Outside the Project area the Project has had major negative impacts, on conditions in adjacent areas which suffer higher flood levels and downstream where the combination of the Chalan Beel D polder with other middle Atrai embankment systems leads to threats of catastrophic flooding. The retreat of the wetlands has caused more significant biotic impacts than in most projects studied by FAP 12, because of its magnitude. Fish ecology and aquatic micro-biota in particular have suffered.

Monitoring programmes should be established for critical environmental parameters, including groundwater levels and quality, extent and quality of wetlands, wetland wildlife including fish, and micro-biota. If such a programme can be set up, and if the Project is successfully rehabilitated, a detailed environmental audit should be conducted about five years after the completion of rehabilitation.

Economic Appraisal

The estimated economic returns to the Chalan Beel Project are disappointing. Assuming no fisheries losses, the agricultural benefits yield an EIRR of 26 per cent, but this a maximum estimate based on one of the (probably rare) years when the protected area showed a superiority over the control. With the lowest estimate of the actual fisheries losses, the Project is marginally viable (EIRR 14.5 per cent), while the higher estimate of fishery losses reduces EIRR to 8.5 per cent.

The Project was not particularly costly, with capital costs at Tk 9196 per benefited hectare (in 1991 financial prices), and O&M costs are not unusually high. The Project's poor performance stems from its very limited agricultural impact, due to the impossibility of proper operation due to offsite impacts, the substantial fisheries losses incurred, and to a lesser extent from the fairly long implementation period (eight years).

If any quantification of off-site impacts on non-Project areas could be made, these would further reduce the EIRR of the Project.

Recommendations

Substantial changes would be needed to develop an approach to FCD in the Chalan Beel Polder D which corrected the present difficulties. These might require a substantial change in the flood control philosophy, and this is currently (1991) under review by the FAP North-West Regional Study (FAP 2). If, on the other hand, the polder is retained in its current form, a substantial review of operating practices, and their implications for outsiders and insiders is essential. This would probably lead to a move to some controlled flooding, and to structural changes in the internal drainage network and in many drainage structures. Any revised plan for Chalan Beel D will only be feasible if it is made in the context of a long-term integrated plan for coordination of development in the Atrai basin.

If the polder is retained in its present form, a programme for rehabilitation of the public cuts, drainage systems and structures will be required to allow the Project to function as planned. This rehabilitation will in turn be effective only if measures are taken to correct the fundamental inequity of Project impacts on insiders and outsiders.

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ABBREVIATIONS AND GLOSSARY

ADB	Asian Development Bank
AED	Agro Ecological Divisions
AER	Agro Ecological Regions
AES	Agro Ecological Subregion
AFB	Atrai-Fakirni-Barnai Active River Flood Plain
BCR	Benefit Cost Ratio
BIDS	Bangladesh Institute of Development Studies
BWDB	Bangladesh Water Development Board
CBPD	Chalan Beel Polder D
DAE	Department of Agricultural Extension
DAU	Draught Animal Units
DOF	Department of Fisheries
DS	Downstream Areas
DTW	Deep Tube well (with positive displacement pump)
EIP	Early Implementation Project(s)
EIRR	Economic Internal Rate of Return
EIA	Environmental Impact Assessment/Analysis
FAO	Food and Agricultural Organisation (of the United Nations)
FAP	Flood Action Plan
FCD/I	Flood Control Drainage/Irrigation
FFW	Food for Works
FPCO	Flood Plan Coordination Organisation
HH	Household
HYV	High Yielding Variety
IEE	Initial Environmental Examination
IRRI	International Rice Research Institute
JICA	Japan International Cooperation Agency
Kcal	Kilocalorie
LLP	Low Lift Pump
LPC	Local Project Committee
LV	Local Variety
MPO	Master Plan Organisation
NGO	Non-government Organisation
NPV	Net Present Value
ODA	Overseas Development Administration
O&M	Operation and Maintenance
PEP	Preliminary Environmental Post Evaluation
PIE	Project Impact Evaluation
PPS	Probability Proportional to Size
PWD	Power and Water Development Board
R&H	Roads and Highways
RRA	Rapid Rural Appraisal
SCF	Standard Conversion Factor
SRS	Simple Random Sampling
STW	Shallow Tube-well (with suction pump)
Tk.	Taka
UP	Union Parishad
UZ	Upazila
XEN	Executive Engineer

THE BENGALI CALENDAR

The Bengali calendar was used for interviewing because of its greater familiarity to most respondents, and some tabulations and figures are presented by Bengali months. 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 Month	Gregorian Month
Baishakh	April
Jaistha	May
Ashar	June
Sraban	July
Bhadra	August
Aswin	September
Kartik	October
Aghrayan	November
Poush	December
Magh	January
Falgun	February
Chaitra	March

1 INTRODUCTION

1.1 THE FAP 12 STUDY

The FAP 12 Study is one of the 26 numbered component studies of the Bangladesh 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 conducted by a group of Bangladeshi and international 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 FCD/I 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 have been assessed mainly by Project Impact Evaluation (PIE) methods, using a formal questionnaire approach and probability sampling. The remainder have been assessed by Rapid Rural Appraisal (RRA) methods, and RRA has also been used for preliminary reconnaissance of the 5 PIE projects. The present report describes the combined findings of the RRA and PIE of Chalan Beel Polder `D' Project (CBPD).

1.2 PROJECT DESCRIPTION

1.2.1 Location

Chalan Beel Polder `D' (CBPD) is located in the upazilas of Mohanpur, Bagmara, Tanore and Manda of Rajshahi and Naogaon districts in north-western Bangladesh (Figure 1.1), falling in the Flood Action Plan's North-West Region and in BWDB's Rajshahi Operation and Maintenance (O&M) Circle. The Project has a gross area of 53,055 ha. The project area is surrounded by four rivers, Atrai, Fakirni, Barnai and Sib (Figure 1.2). Although the project area has no large towns, Rajshahi metropolitan area lies just beyond its southern limit while the district town of Naogaon is not far from its northern boundary.

1.2.2 Physical Characteristics

The Project area is low, old or young alluvial delta with irregular relief in elevation from 10.2 to 16.7m above mean sea level(PWD). Rainfall averages 1400 mm. per year. Pre-Project, large areas flooded up to a depth of 1.5 m every year and almost all areas experienced some flooding. The project area abounds in many large and small beels. Areas surrounding these beels used to be deeply flooded.

1.2.3 Outline of Project Design and Objectives

CBPD is a Flood Control and Drainage (FCD) Project. It is designed as a polder with embankments all around the project area with regulators at specific sites for facilitating drainage along natural channels (khals) inter-connecting the beels and the rivers. There are also provisions for some irrigation inlets.

The objectives of the main embankment and drainage system design were to protect the Project interior from river flooding and drainage congestion respectively during the monsoon, thus improving agricultural conditions in the monsoon and increasing the security of crops.

The Project as planned and implemented was not a multi-sector one. It may be mentioned, however, that in at least three aspects the Feasibility Report sounded rather severe warnings. These related to ground water hydrology, fisheries and the livestock situation in the project area. Unfortunately these were either not heeded or followed up, with a single-minded pursuit of growth of crop-agriculture.

1.2.4 Project History

The Project was identified by BWDB and the International Development Agency (IDA) in the seventies. Feasibility and related water balance and hydrological studies were carried out in 1979 and 1980. The IDA appraised the project in 1981 and construction commenced during the fiscal year 1981/82. The Project was officially declared as completed in 1988/89 but the essential structures, the whole embankment and most of the regulators were already in place by 1985/86. Some damage due to the 1987 and 1988 floods was repaired over 1987/88 to 1990/91.

1.3 METHODOLOGY

1.3.1 Previous Evaluations

In selecting projects for PIE study, FAP 12 deliberately excluded those for which a previous evaluation of good quality had been made, thereby avoiding unnecessary duplication of effort. In the case of CBPD one post-evaluation has been made (BETS, 1989) in 1989. Because of short-comings in the evaluation, the consultants decided to evaluate it again using the PIE method.

The BETS evaluation provides some insights into project impacts but may not serve as a valuable source of information for evaluation of the project impact for the reference year or for comparison with the present findings. To begin with the field interviews were conducted in 1989 but the reference year for collection of household information was 1986-87 as this had been temporally the nearest normal year. Even if one sets aside the question of reliability of recall over a long period for quantitative information, one possibly could not expect the project impacts to follow immediately and fully upon completion.

The FAP 12 PIE did not re-use the BETS household survey villages, since these were not selected by probability sampling (see below) and also because only a few villages (5) and a few households (25) could be compared in this manner. The study, however, has been used extensively during RRA.

The control area chosen for impact evaluation falls within the jurisdiction of the Barnai Project which is under construction. Although the Barnai Project documents provide useful back-ground information on physical and hydrological aspects of the area, no socio-economic information was available to the consultants for comparison.

1.3.1 RRA and PIE Surveys

FAP 12's methodology for project evaluation has been described in detail in the FAP 12 Methodology Report (FAP 12 1991a) and the experience with its application in practice has been reviewed in the FAP 12 Final Report (FAP 12 1991b). Its main features are therefore only briefly summarised here.

FAP 12 has used two different but complementary approaches to project evaluation. These are Rapid Rural Appraisal (RRA) and Project Impact Evaluation (PIE). RRA is an informal survey technique intended to produce results more quickly than formal interview surveys, while avoiding biases in the data collected. It consists of selective direct observation and interviews conducted by a small team of well-qualified and experienced specialists who can reach informed judgements quickly in the field. Although some quantification of RRA results is possible, by its nature RRA is better at obtaining qualitative than quantitative data, and it cannot (in contrast to probability sample surveys) provide statistical verification of the size and extent of observed impacts.

The PIEs, in contrast, were formal questionnaire surveys using probability sampling for the core samples, and thus having the capability for collection of highly quantified data which would support statistical testing. The two approaches are however complementary. Each of the 5 PIEs was preceded by an RRA, which served as a reconnaissance of the area and which collected data on the condition and performance of the engineering structures and the operation and maintenance institutions of the project. In addition to the main RRAs of the PIE projects, which were conducted in March-April 1991., repeat visits were made in September-October 1991 to supplement the engineering and operation data with observations during the high water period.

1.3.2 PIE Survey Methodology

a) Measurement Approach

Measurement of project impacts in the PIEs was by the control area approach, in which observations in the impacted area of a project are compared with those from a non-project area (the control) which had similar conditions to the project area at the period before the project was implemented. The control area will have been subject to any general trends in operation since project completion, so that any differences between project and control should be attributable to the net influence of the project. PIE control areas were selected on the basis of similarity to the project areas in terms of pre-project flood depths and agricultural conditions, and subsequent analysis has shown that in general a high level of comparability was achieved.

b) Probability Sampling

The core of the PIE surveys was two probability samples of households, one of cultivators (defined as any farm operator, regardless of type of land tenure) and the other of landless labour households. Probability sampling was adopted in order to confer the ability to test for statistically significant differences between the impacted and control areas. The sample design was two-stage, to minimise logistical problems in compiling sample frames, the first stage consisting of mouzas (revenue villages) and the second of households. Selection of the first stage was with probability proportional to size (PPS) and of the second stage by simple random sampling, the PPS/SRS design being self-weighting.

Sample size for each PIE was set at 120 cultivating and 48 labour households for the impacted area, and 60 cultivating and 24 labour households in the control area. The larger sample size for the impacted area was set in order to permit post-stratification between respondents inside the project (impacted/protected) and those outside but influenced by the project (impacted/unprotected). The cluster size of respondents taken from each first-stage unit was limited to 5 cultivator and 2 labour households, in order to minimise the adverse effect of intra-cluster correlation on precision. The expected mean sample size of 60 per stratum (impacted/protected), impacted/unprotected and control) was expected to permit estimation of crop yields (the key agricultural parameter) with 75 per cent confidence interval of 10 per cent of the mean. In practice, in most of the PIEs precision was somewhat better than this.

The first-stage sample frames were taken from the Small Areas Altas of Bangladesh, which lists mouzas with their populations from the 1981 Census. Second-stage sample frames were compiled from the local taxation rolls maintained by the Union Parishads (the next administrative level above the mouzas) which include all household heads. The rolls were updated, and details of main and secondary occupation obtained, with the help of local informants immediately in advance of each PIE.

Female respondents were sampled from both cultivating and labour households in 50 per cent of the respondent clusters, providing a probability sample of 60 female respondents from cultivating and 24 from labour households in the impacted areas, and 30 from cultivating and 12 from labour households in the control areas.

c) Non-Probability Samples

For some categories of households, including fishermen, fish traders and operators of non-farm rural enterprises it was not logistically feasible to compile satisfactory sample frames for probability sampling. These groups were therefore the subject of questionnaire case-studies aimed at illustrating the project impacts, but without the ability for statistical generalisation. In each of the impacted and control areas a total of 15 fishermen, 5 fish traders and about 15 operators of rural enterprises (grain and input traders, artisans, transport operators, etc.) was interviewed. In addition,m the female members of all the households in the non-probability samples were interviewed.

d) Field Procedures

The PIE survey programme was conducted between late May and early November 1991. Fieldwork for each PIE was executed in a period of approximately a month, the main enumeration effort taking about 3 weeks and being preceded by an advance party to compile sample frames and set up logistical arrangements. A team of 15 enumerators was employed (3 of whom were women who interviewed only the female respondents) working under 6 supervisors, who also compiled the sample frames under professional supervision and conducted post-survey questionnaire checking. The questionnaire was modular in design, to permit selective administration for activities (such livestock and fish pond ownership) not undertaken by all households. The questionnaire was pretested before the start of the PIEs, and was again modified slightly after the first PIE at Zilkar Haor.

e) Data Processing

Data entry was conducted with the dBase III+ package and the main tabulations were produced with SPSS. Secondary processing for calculation of standard errors was done with a combination of dBase and Lotus 1-2-3. The algorithms used to calculate standard errors from the PPS/SRS sample data are given in Annex P to the FAP 12 Draft Final Report.

1.3.3 The RRA and PIE Surveys of CBPD

The preliminary RRA of CBPD was conducted in March 1991 by a multidisciplinary team consisting of an economist (team leader), two agriculturists, a civil engineer, a rural institutions specialist and a fisheries specialist. Subsequent visits were made by FAP 12 engineers to collect additional data on the Project's construction, rehabilitation and operating costs, and by two environmentalists to make a more intensive Preliminary Environmental Post-Evaluation (PEP).

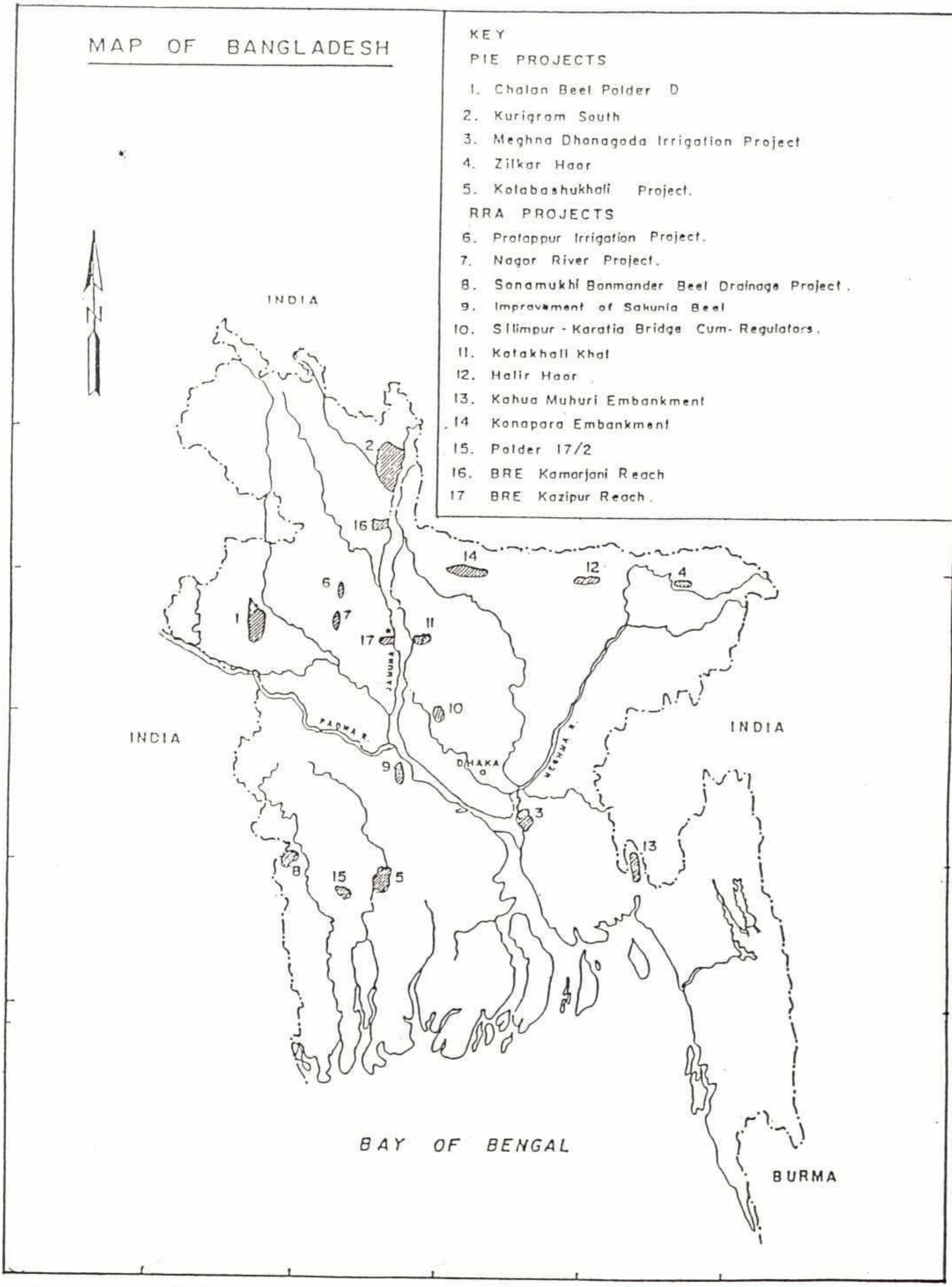
The PIE survey in CBPD was conducted in June and July 1991, following the methodology described in Section 1.3.2 above. The control area selected for comparison with the Project area is to the south-east of CBPD, falling in the Durgapur Upazila (see Figure 1.3). This area is closely comparable with the Project area in distribution of land area by pre-Project flood depth (see Chapter 2 on Engineering and Hydrology).

In the impacted area a total of 120 cultivating and 48 labour households was sampled in 24 clusters, falling in 20 different mouzas, while 60 cultivating and 24 labour households, in 12 different mouzas, were sampled in the control area. The locations of sampled mouzas are shown in Figures 1.2 and 1.3.

1.4 ACKNOWLEDGEMENTS

FAP 12's staff spent extended periods in the CBPD area during 1991. In the course of their work they were courteously and cooperatively received everywhere, and this opportunity is taken to express the study team's thanks to all those concerned. Special thanks are due to the officials in Mohanpur, Manda and Bagmara Upazilas, to the Superintending Engineer and staff of the BWDB Rajshahi O&M Circle, to the Chairmen and Members of the Union Parishads in the survey areas, and to the Principal and staff of the Teachers Training College, Rajshahi. Last, but by no means least, FAP 12 wishes to thank the over 400 farmers, labourers, fishermen, fish traders and rural entrepreneurs, who with the women of their households gave their time and shared their experience with the study teams.

Figure 1.1 Location of Selected PIE and RRA Projects



Source: Consultants

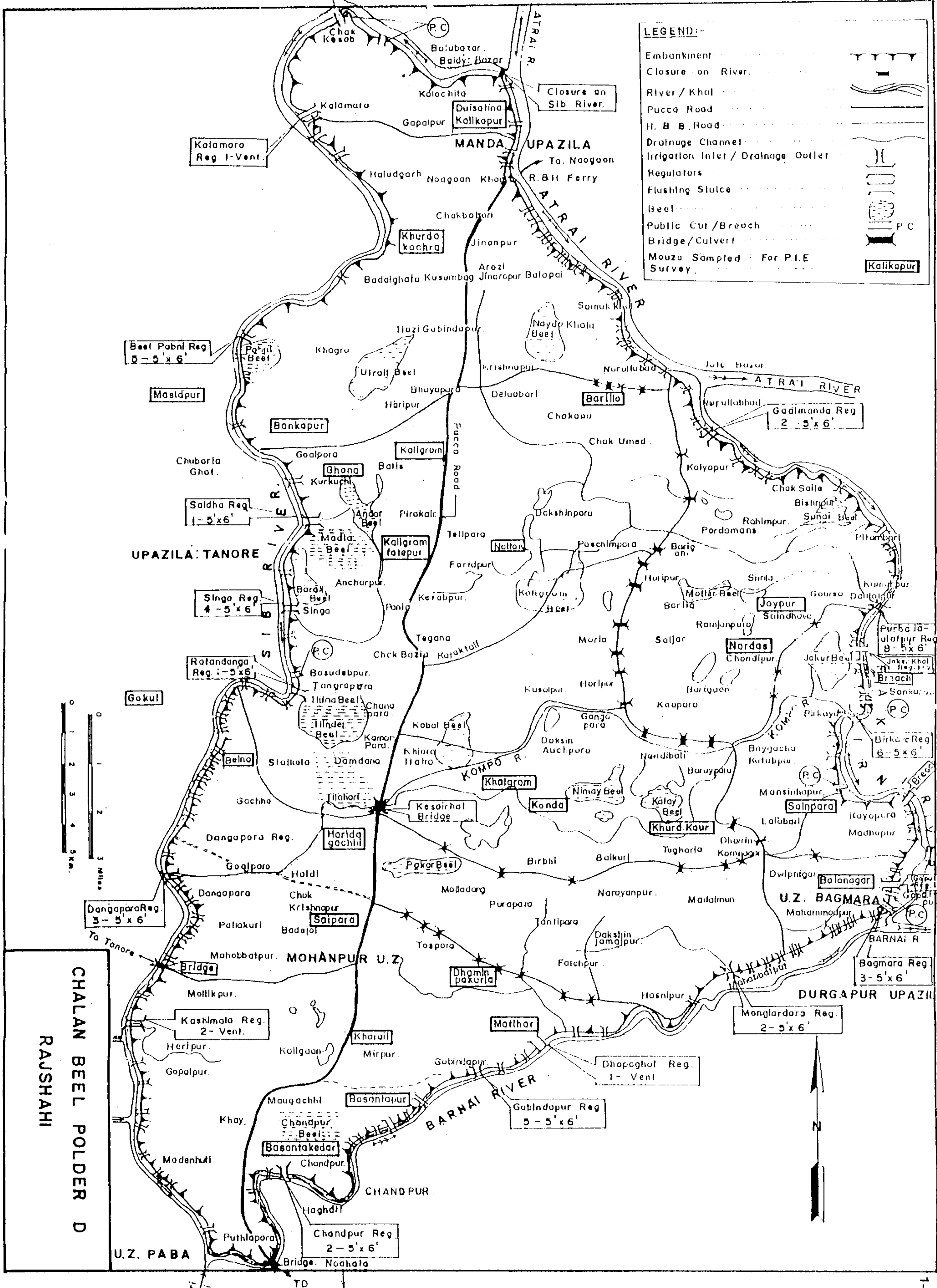
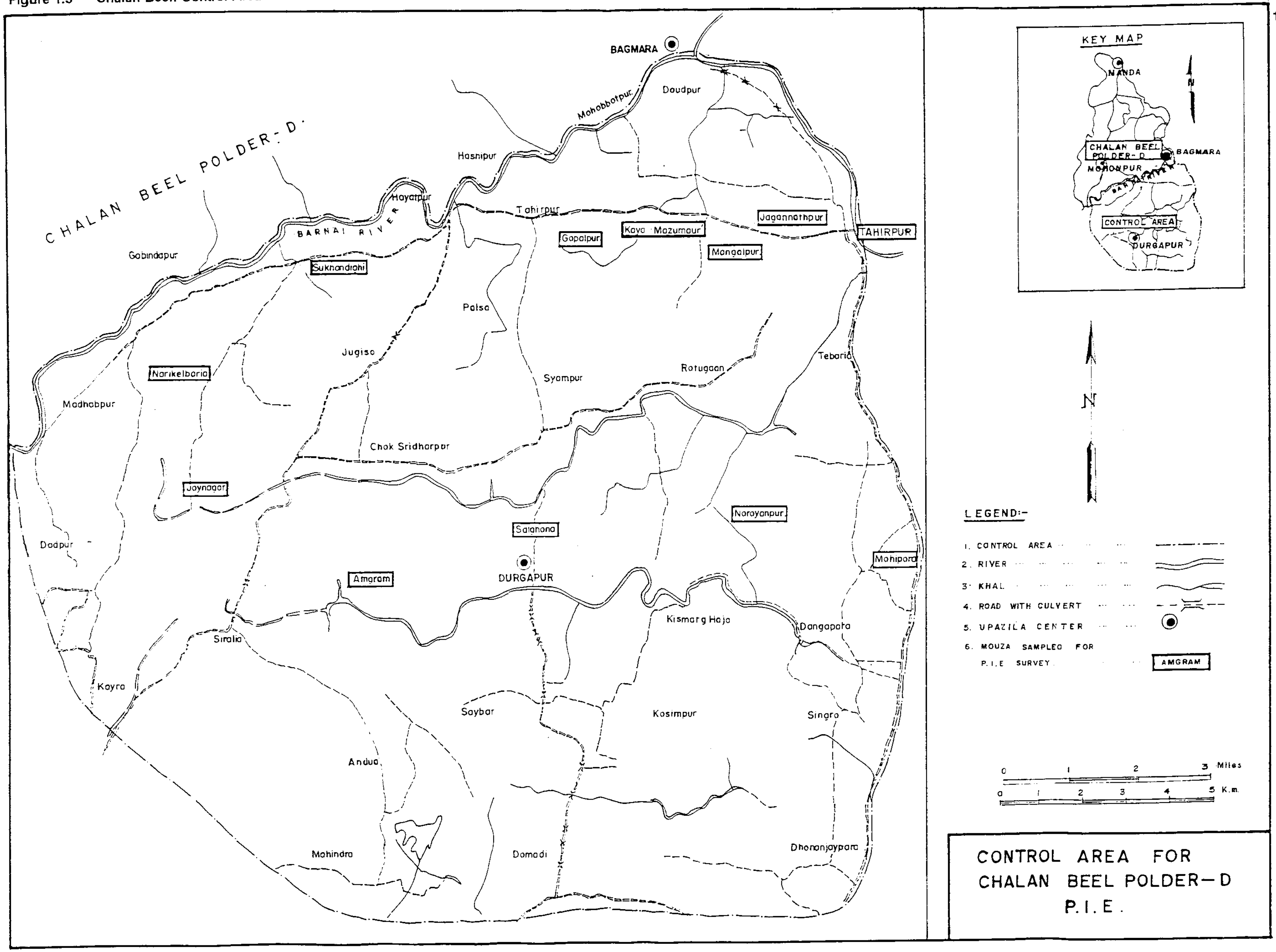


Figure 1.2 Chalan Beel: Impacted Area

Figure 1.3 Chalan Beel: Control Area



2 ENGINEERING ASPECTS

2.1 PRE-PROJECT SITUATION

2.1.1 Flood and Drainage

The general topography of the project area is rather flat sloping from the North-West to the South-East, though the micro topography is quite complicated. Historically the project area has been subjected to annual flooding during the monsoon. The four rivers Atrai, Fakirni, Barnai and Sib were the main drainage channels during the pre-project period draining-out water accumulating due to local rainfall and flood water coming from the north and north-west.

During the period, prior to the implementation of the Project, about 53 per cent of the area used to go under water in an average year with a maximum depth of one to one and a half metres (Table 2.4). Shallowly flooded land (about a quarter) was the next most important category.

A major feature of the Project area is that there are a large number of beels, large and small, dotted all over the area, particularly in the western and the middle and southern sections. During the monsoon and particularly during the pre-project period these used to interconnect and served as channels for drainage from the River Sib side to the River Fakirni side of the Project area.

2.2 PROJECT OBJECTIVES

In compliance with the objectives set forth in the third five year plan (TFYP) BWDB initiated the Chalan Beel Polder 'D' to provide:

- drainage and flood control facilities with limited irrigation, empoldering the project area;
- food self sufficiency;
- expansion of productive employment;
- acceleration of economic growth;
- promotion of self-reliance.

The long term goals of the project were to increase agricultural production, create employment opportunities and improve living conditions of the farmers.

Farming in the project area in the pre-project situation depended mainly on low-yielding B. Aman which was damaged almost every year due to flood. A specific objective of the project has been to reduce such damage and increase cropping intensities and crop yields. A flood protection embankment and water control structures, drainage improvements, supplementary irrigation facilities, provision of agricultural extension services and strengthening of O&M services were to be put in place to lead to such changes.

2.3 PROJECT STRUCTURES AND PRESENT STATUS

The Chalan Beel Polder 'D' sub-project comprises a large number of structures. The major structures are described in the following sub-sections

2.3.1 Embankment

In the original project proforma and in the Feasibility Study the total length of the embankment was 133.63 km.. But in the revised project proforma (latest) the length of the embankment was revised as 132.28 km.. The embankment was constructed fully as per design except at three places of Murshidpur and Chauapara Village under Bharso Union. It was reported by the Union Parishad Chairman of Bharso that the embankment was not constructed at these points due to land acquisition problems.

During RRA and later during more focused engineering investigations several problems have been observed related to cuts, breaches, rain cuts and wave actions as described below.

a) Cuts and Breaches

During the floods in 1986/87 there were 33 natural breaches and public cuts.

Looking at the map (Fig. 1.2) one can easily discover a pattern in the public cuts. The cuts on the River Sib side and those on the River Fakirni side have between them the swathe of ground interpersed with beels, low-lying areas and channels (including Kompo River) which suggests a natural path for the flowing water. On the river side of River Sib, in and around the locations of cuts, there are large beels where water pressure obviously mounts rather quickly during the monsoon, threatening homesteads and crops on the unprotected side.

b) Rain-cuts

Discussion with the BWDB Staff, interviews with local people and on site observations indicated that about 40 per cent of the embankment was damaged due to rain cuts which need to be repaired/rehabilitated.

c) Wave Actions

The flood control embankment passes through several lowlying areas in the active flood plains of the R. Sib separating the beels from the river. During the monsoon the beels accumulate rain water and expand up to the embankment. As a result the embankment seems to float in large water bodies (both on the country side and river side) at several locations and is subjected to huge waves on both sides. The suction of the huge waves hitting both sides of the embankment has caused slip failure on the embankment slopes to different degrees depending on the kind of materials, side slopes, compaction, protective turfing etc.. To protect the affected parts of the embankment from wave action, costly brick mattressing was used at several reaches. It was seen during the return field visits that the brick mattressing works were damaged badly at several locations (at 9 places as reported by BWDB officials) of which the failure near the Singa regulator was the worst, where about ½ to ⅔ of the embankment section has slipped down along with the brick-mattressing. The reasons for such failure seemed to be the improper toe works for the brick mattressing.

2.3.2 Regulators

17 regulators have been constructed although the original PP had a provision for only 9 regulators and the revised project proforma proposed a total of thirteen. The locations of the regulators are shown on Figure 1.2. The ventage of the regulators varies from 1 to 8 vents with vertical lift gates and they were constructed as per design specification. A few of the regulators were found to be in defective condition due to problems of gates. The gate operating arrangements (ie the Gear Box) for some regulators need minor repair and some regulators need to be provided with protective works. In some cases parts were missing or had been taken away (see section on Socio-economic Impacts). The summary of the condition of the main drainage/flushing structures in Chalan Beel Polder 'D' is shown on Table 2.1.

It is noticed from Table 2.1 that the wing walls and the boxes of the regulators are in good condition in all the regulators. The loose aprons are mostly damaged (12 out of 17 on river side and 9 out of 17 on country side). The steel gates are in good operating condition except in three where the gear boxes are missing. All the gates are leaking as their rubber seals are damaged.

2.3.3 Irrigation Inlet

In the third revised project proforma there was a provision for 77 Nos. irrigation inlet. These were constructed as per design requirement. All are in good condition except 2 which need to be reconstructed as they were demolished due to public cuts to the embankment.

It was understood that farmers feel the necessity for more irrigation inlets to irrigate from the river by LLP. Concerned BWDB staff have proposed 17 irrigation inlets in addition to the existing ones.

2.3.4 Drainage Outlet

In the third revised project proforma 8 Nos. Flushing sluice/Drainage outlet (1 vent) were proposed and subsequently implemented. All these structures are functioning well. To meet the project requirement in the present and future additional 4 nos. Flushing Sluice/Drainage outlets are proposed by concerned BWDB staff.

2.3.5 Drainage Channel

The original PP provided for excavation of 193.08 km. of drainage channels. This was brought down to 137.49 km. in the revised PP. The drainage channels are now partly silted up and re-excavation of 22.87 km of drainage channel needs to be conducted according to concerned BWDB staff.

2.3.6 Roads

In the original PP there was a provision of 48.27 km. of main roads and 96.54 km. of village roads. In the latest PP construction of 76.09 km. main road and 25.65 km. village road was provided for. Both the main and village roads are in fair condition, except that about 20 per cent need repair works.

Table 2.1 Summary of Condition of Main Drainage/Flushing Structures in Chalan Beel Polder 'D'

Type and Location of Structure	Present condition of structures									Present Condition of Drainage Channel	
	Regulator/Sluice							Gate			
	No. of Ventage	Type of Gate	Wing wall		Box	Apron		Gate	Rubber Seal/ Groove		
			C/S	R/S		C/S	R/S			C/S	R/S
Kashimala Drainage Regulator	2	V.L.	G	G	G	F	F	G	R.S to be provided	F	F
Dangapara Drainage Regulator	3	V.L.	G	G	G	F	L.A. to be constructed	G, one gear box missing	R.S to be provided	G	F
Ratandanga Drainage Regulator	1	V.L.	G	G	G	F	F	G	R.S to be provided	G	F
Singa Drainage Regulator	4	V.L.	G	G	G	F	F	G	R.S to be provided	F	G
Saldha Drainage Regulator	1	V.L.	G	G	G	F	F	G	R.S to be provided	F	F
Beel Pabni Drainage Regulator	5	V.L.	G	G	G	F	F	G	R.S to be provided	F	F
Kalamara Drainage Regulator	1	V.L.	G	G	G	F	G	G	R.S to be provided	F	F
Goalmanda Drainage Regulator	2	V.L.	G	G	G	F	F	G, 1 gate need repair	R.S to be provided	F	F
Purbadaulatpur Drainage Regulator (Brick Masonry)	8	V.L.	G	G	G	G	F	G	R.S to be provided	G	G
Joker khal Drainage Regulator	1	V.L.	G	G	G	G	F	G	R.S to be provided	G	F
Birkaya Drainage Regulator (Brick Masonry)	6	V.L.	G	G	G	G	G	G	R.S to be provided	P	F
Gopalpur Drainage Regulator	1	V.L.	G	G	G	G	F	P, penium is missing	R.S to be provided	F	P
Bagmara Flushing cum Drainage Regulator (Brick Masonry)	3	V.L.	G	G	G	G	G	G	R.S to be provided	F	F
Monglardara Drainage cum Flushing Regulator	2	V.L.	G	G	G	G	G	G	R.S to be provided	F	F
Dhopaghat Drainage cum Flushing Regulator	1	V.L.	G	G	G	F	F	G	R.S to be provided	F	G
Gobindapur Drainage Regulator	5	V.L.	G	G	G	G	G	G	R.S to be provided	F	G
Chandpur Drainage Regulator	2	V.L.	G	G	G	G	F	G	R.S to be provided	F	F

Source: Consultants

Note: C/S - Country Side; R/S - River Side; V.L. - Vertical Lift; G - Good; F - Fair; P - Poor; N/A - Not Available

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2.4 PROJECT COSTS

The estimated cost for the CBPD went through various revisions over time. The Feasibility Study estimated the project implementation cost to be Tk.285 million while the originally approved cost had been much less, Tk. 226.13 million. The third and final revision of the PP put the estimated cost at Tk. 373.23 million. It is quite likely that the actual expenditure may have been somewhat higher as the Project Completion Report indicates that there have been additional cost components not mentioned in the final revision of the PP. An itemwise comparison of cost between the Feasibility Report and Revised PP is shown in the Table 2.2. These indicate that just over a third of the Project cost involved construction of the embankment (including cost of land acquisition) while a third more had been for construction of roads and regulators.

2.5 ASSESSMENT OF HYDROLOGICAL IMPACTS

2.5.1 Introduction

The direct project impacts due to FCD/I intervention are primarily hydrological changes which denote differences in water conditions between pre- and post-project.

Major physical features and hydrological information related to the Project additional to those in Table 2.1 are summarised in Table 2.3.

2.5.2 Hydrological Impacts

a) Flood Type

The Chalan Beel Polder D is a typical case of Flood Type L (Local flooding and internal drainage) featuring local flooding and congestion of internal drainage basins. (Flood type: see Vol I, sub-section 3.4.1).

The flow capacities in the four rivers (Atrai, Fakirni, Barnai and Sib) are insufficient to carry the monsoon flood (see below). The high external water levels last throughout the monsoon season and consequently confine the internal rain water inside the project area.

b) Key Hydrological Impacts

Post-Project hydrological characteristics in the Chalan Beel Polder D are representative of Flood Type L. The intended targets in delayed onset of floods, reduced normal flood depth and prevented peak floods are moderately achieved inside the project area. However, such hydrological conditions as drainage congestion, siltation, bank erosion, increased water levels outside the protected area and breaches/public cuts were exacerbated after the project. This is due to confinement of water flow into the relatively small river sections.

The Atrai and Nagor River basin hydrology has been studied by various organisations. The EIP study group (EIP, 1988) predicts a rise of about 2-3 m. in river water levels in the region after full confinement of the rivers by embankments.

Table 2.2 **Comparison between itemwise quantities and cost estimates as shown in Feasibility Report, and latest P.P. on the sub-project.**

Sl. No.	Item of Work	Feasibility Report (Oct. 1988)		Latest P.P.	
		Quantity	Cost Estimate (Tk. million)	Quantity	Cost Estimate (Tk. million)
1.	Land acquisition	-	-	570.31 ha.	57.16
2.	Main road	50.00 km.	39.00	76.09 km.	54.50
3.	Village road	95.00 km.	-	25.65 km.	3.00
4.	Bridge	-	-	10 Nos.	5.05
5.	Pipe/Box culvert	-	-	20 Nos.	1.31
6.	Embankment	133.50 km.	114.00	132.28 km.	74.45
7a.	Drainage channel	2.04 mm^3		123.58 km.	7.60
7b.	Drainage channel	0.42 mm^3	94.00	13.91 km.	FFW
8.	Regulator	*		13 Nos.	56.10
9.	Flashing sluice/drainage outlet	-		8 Nos.	6.76
10a.	Shallow tube well	1600	38	77 Nos.	4.25
10b.	Irrigation inlet/drainage outlet	-	-	-	-
11.	Irrigation inlet for LLP	-	-	22 Nos.	2.61
12.	Installation of gates for irrigation and drainage inlet/outlet	-	-	39 Nos.	2.26
13.	Protective work with brick mattressing	-	-	305 Nos.	1.52
14.	O&M during const.	-	-	L.S.	31.23
15a.	Functional Building	-	-	5 Nos.	0.71
15b.	Residential Building	-	-	2 Nos.	0.94
16.	Transport and Vehicle	-	-	16 Nos.	1.61
17.	Machinery and Equipment	-	-	19 Nos.	3.45
18.	Man Power	-	-	L.S.	35.23
19.	Overhead cost	-	-	L.S.	16.93
20.	Consultancy/(Bench mark survey evaluation study)	-	-	L.S.	1.50
21.	D.S.L.	-	-	L.S.	4.54
	Total		285.00		373.20

Source: 1. Feasibility Report Vol.- 1
2. SAR, WB, 1981
3. Revised PP (Oct. 1988)

Note: * - 8 pumping plants and 1 gravity sluice

Table 2.3 Summary Sheet for Physical and Hydrological Features (Chalan Beel Polder D)

Project Type	: Flood Control and Drainage		
Embankment High Water Level	: 18.32 m. PWD		
Design Probability	: 1/100 Years		
Number of Regulators	: 17 Nos.		
Irrigation Inlets	: 77 Nos.		
Drainage Channel	: 137.49 km.		
Water Level Record	: Jotebazar [16.09 m PWD][1] Bagmara [14.59 m. PWD] Nowhata [13.86 m. PWD]		
Damage during 1987 Flood	: Public Cuts 30 Nos. Breaches 3 Nos.		
1988 Flood	: Public cuts	Sib River	Balubazar Chak kesab Basudebpur Gopalpur
		Fakirni River	Birkaya Mansinhapur
	Breaches	Fakirni River	Sankarpur Chak Saile
Normal Flood Years	: 1979 - 1985, 1989 - 1991		
Above Normal flood Years	: 1986, 1987, 1988		

Source: BETS Report. (Table 12, Appendix A-2)
Note: [1]Data inside square brackets indicate danger levels.

The Sib River, which was originally a distributary of the Atrai River, off-takes at Baidyar bazar and flows into the Barnai River at Naohata. It was closed at its off-take in the late 1970's and now it carries only the overland spills of monsoon rain from higher Barind areas on its right bank. It is now a non-perennial river. Since it does not carry any flow from the Atrai River, its bed is silted up and subsequently its bankfull capacity has been reduced and as a result even a moderate rain fall in the Barind area resuls in a higher water level in Sib River than before.

During the pre-project period the Sib River used to receive water both from the Atrai River and the Barind area on the right bank. During the monsoon the flood water spilled over

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the left bank and flowed through the beels and the Kompo River, finally falling into the Fakirni River on the eastern boundary of the project. Construction of the embankment all along the left bank of this river prevents flood water from passing through the same route and as a result the water level rises higher than in pre-project conditions and submerges the existing houses and fields on the right bank riverside areas. As a result the affected outsiders now cut the embankment regularly near Tangrapara and at other nearby locations each year.

The Kompo River, during the pre-project condition, connected the Sib River to the Fakirni River. Its closure by the embankment at both its ends, without providing regulators with sufficient capacity to drain out the accumulated rainwater inside the project, causes acute drainage congestion. The situation is further aggravated by the public cuts at Tangrapara. As a result the affected insiders cut the embankment near Birkaya on the River Fakirni side, each year, to save their standing crops and household properties. This problem of public cuts cannot be checked until and unless the negative effect due to change in hydrology both inside and outside the polder is eliminated or substantially reduced.

The Fakirni River is also a distributary of the Atrai River, off-takes at Jote bazar and flows into the Barnai River near Bagmara. This is also a seasonal river as its off-take completely dries up during winter.

The section of Barnai River at the confluence of River Fakirni and River Barnai near Bagmara is not wide enough to carry the combined flow of Fakirni and Barnai and as a result the water level/back flow builds up in both the rivers during monsoon. This back flow/heading up has adversely affected the drainage capacity of the nearby regulators both in the Fakirni and Barnai Rivers.

c) Post-project flooding

The construction of the embankment started in 1981/1982 and by 1985/86 it was completed to provide flood protection to the project area, although the outside area remained exposed to normal flooding.

However, the water levels in 1986, 1987 and 1988 were relatively high and consequently flood water intruded into the project area through the gaps due to natural breaches and public cuts. Therefore, no distinct differences in terms of degree and extent of inundation in the areas adjacent to the project between the pre- and post-project periods was observed. This is supported by the hydrographs in Figure 2.1, 2.2 and 2.3 which show R/S water levels in pre and post project years at three locations (see Project Map) adjacent to Chalan Beel Polder D.

It should be noted that the water level records at the surrounding rivers during the 1987 and 1988 floods are not as high as estimated by the probability analysis in Table 2.7 because of water level falls caused by the breaches and public cuts.

d) Water Level Analysis

Preliminary water level analysis has been conducted employing the water level data at Jotebazar (82), Bagmara (83) and Nowhata (261) shown in Figures 2.1 - 2.3 and Tables 2.5 and 2.6.

The impact of all the above hydrological changes on the project area as a whole in terms of inundation has been that in the normal inundation year after project completion (1985) there had been a very substantial change in the flood-depth status of land within the Project area (Table 2.4). Two thirds of the land experienced either no flood or very little flooding. In 1987, a year of abnormal flood, the experience had been similar to the pre-project situation due to cuts and breaches as explained above. In fact conditions were worse. The proportion of deeply flooded land was 4 times that during the pre-project years.

Table 2.4 Area by Depth of Inundation in CBPD Before and After the Project (ha.)

Flood depth	Pre-Project	Post-Project Normal Year (1985)	Post-Project Abnormal Year (1987)
Non-flooded (up to 0.30 m.)	591 (1)	25169 (47)	1196 (2)
Shallowly flooded (0.31 - 0.90 m.)	13657 (26)	9461 (18)	4860 (9)
Medium flooded (0.91 - 1.52 m.)	28095 (53)	11080 (21)	21465 (41)
Deeply flooded (1.53 m. +)	4787 (9)	1420 (3)	19609 (37)
Perennial water bodies	5925 (11)	5925 (11)	5925 (11)
All	53055	53055	53055

Source: Adapted from NEDECO, (1979); p. 33 and BETS, -DPC, 1979 pp. III-9 to III-10
Note: Figures in parentheses are percentages of total Project area.

The high water level of 16.32 m. PWD corresponding to the design probability of 1/100 years (see Table 2.7 and A.2) has good agreement with the result of the probability analysis by Gumbel's formula (Table 2.7 and A.1) 18.76 m. PWD at Nowhata (261) and Jotebazar (82) respectively.

The designed crest elevation of 19.22 m. PWD was obtained by adding the free board allowance of 0.90 m. (see Table 2.3). The balance between the designed crest elevation (19.22 m. PWD) and the maximum water level (16.85 m. PWD) at Jotebazar in 27 July 1987/88 (see Figure 2.2) suggests that public cuts reduced the water level below that which it would otherwise have been expected to reach in a 1/100 year flood.

e) Cuts and Breaches

During the floods of 1986/87 there were 33 natural breaches and public cuts. Six public cuts were made at Gopalpur, Mansingpur, Birkaya, Basudebpur, Chak Kesab and Balubazar and two natural breaches occurred at Sankarpur and Saildha during the flood of 1988. Two public cuts were made in 1990 at Tengrapara (Ratandanga) and Madhupur due to social conflict though there was no abnormal flood in this year.

Figure 2.1 Water Level Record (1) (CB - 1983/84)

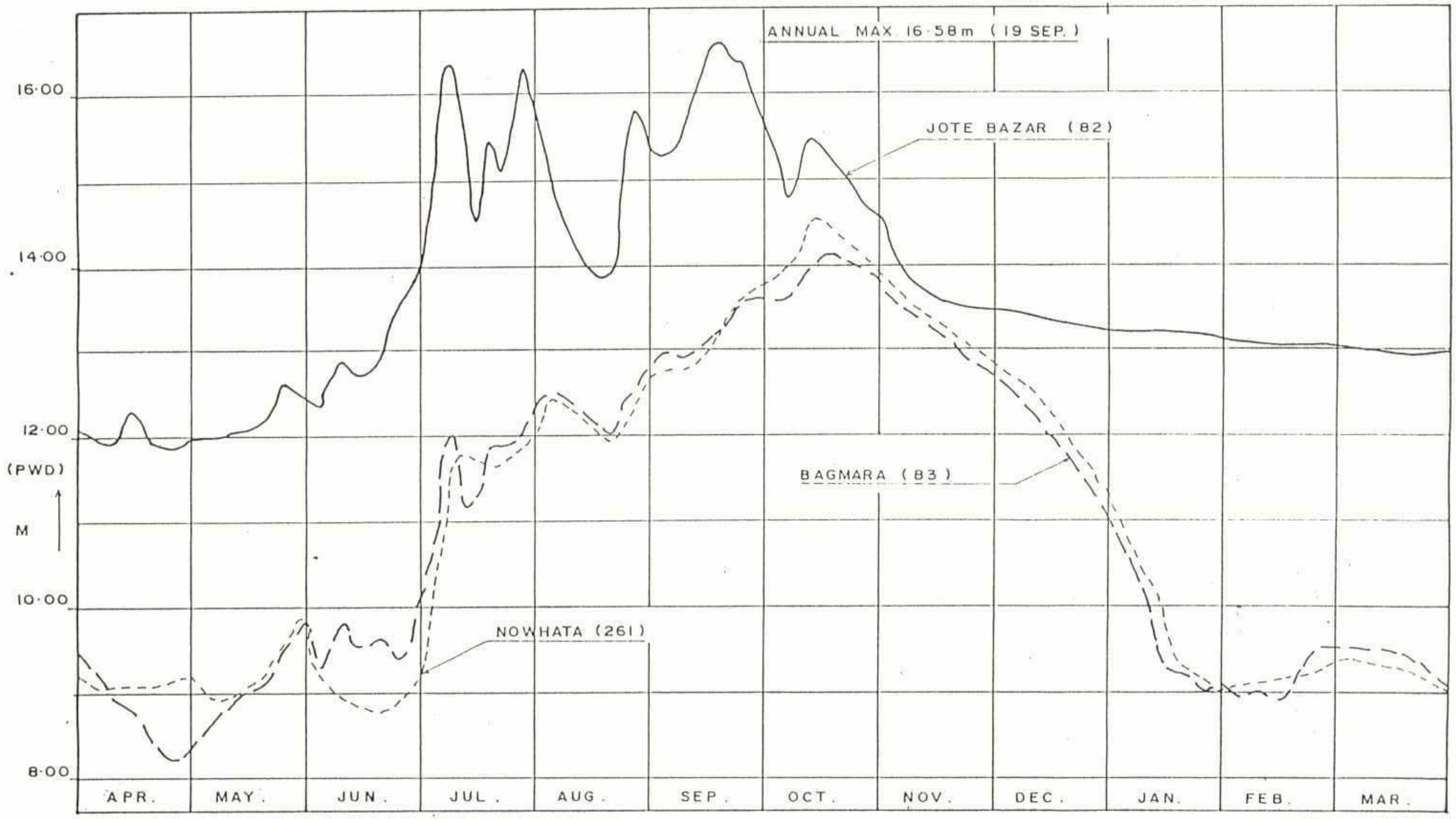


Figure 2.2 Water Level Record (2) (CB - 1987/88)

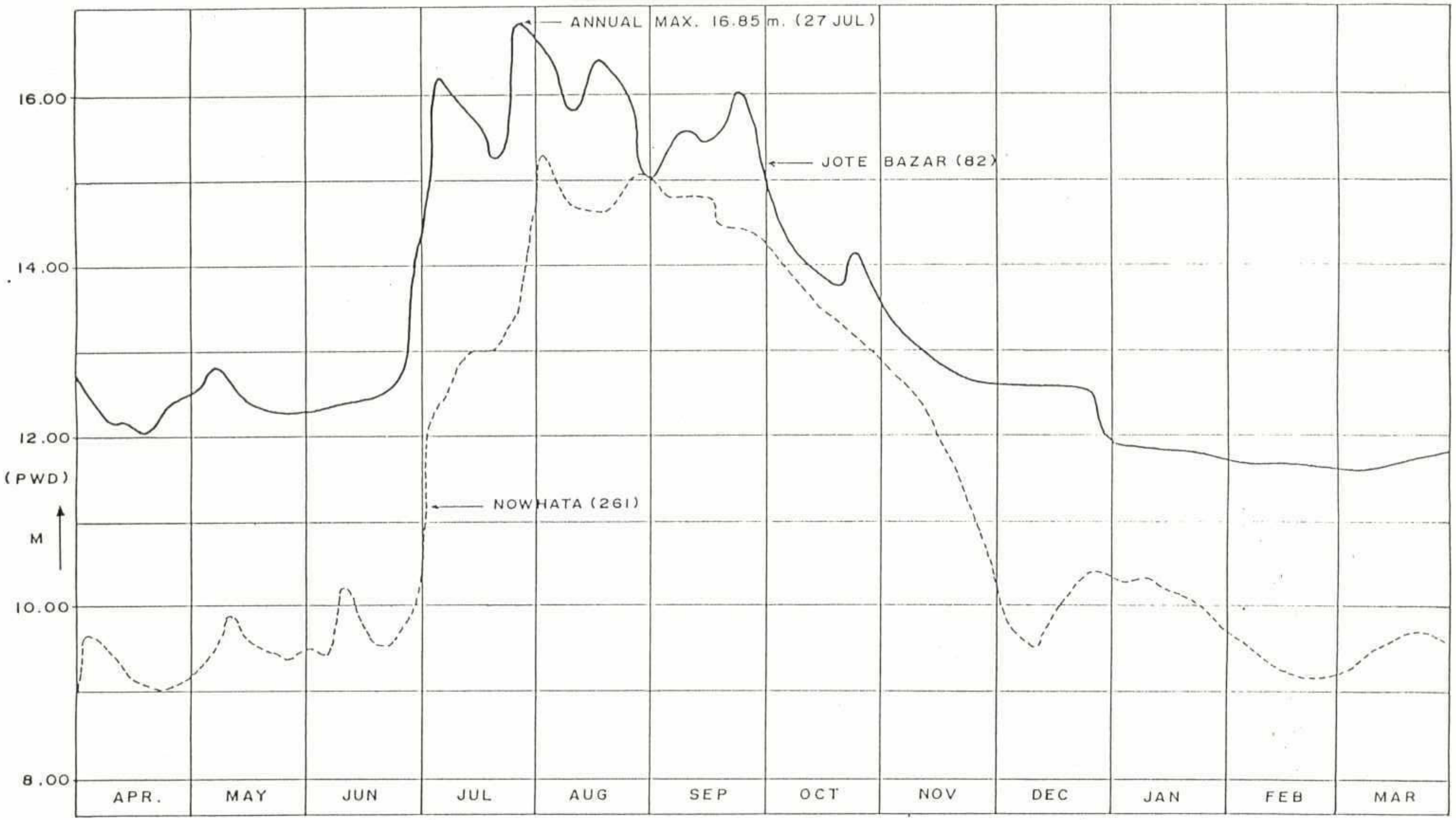
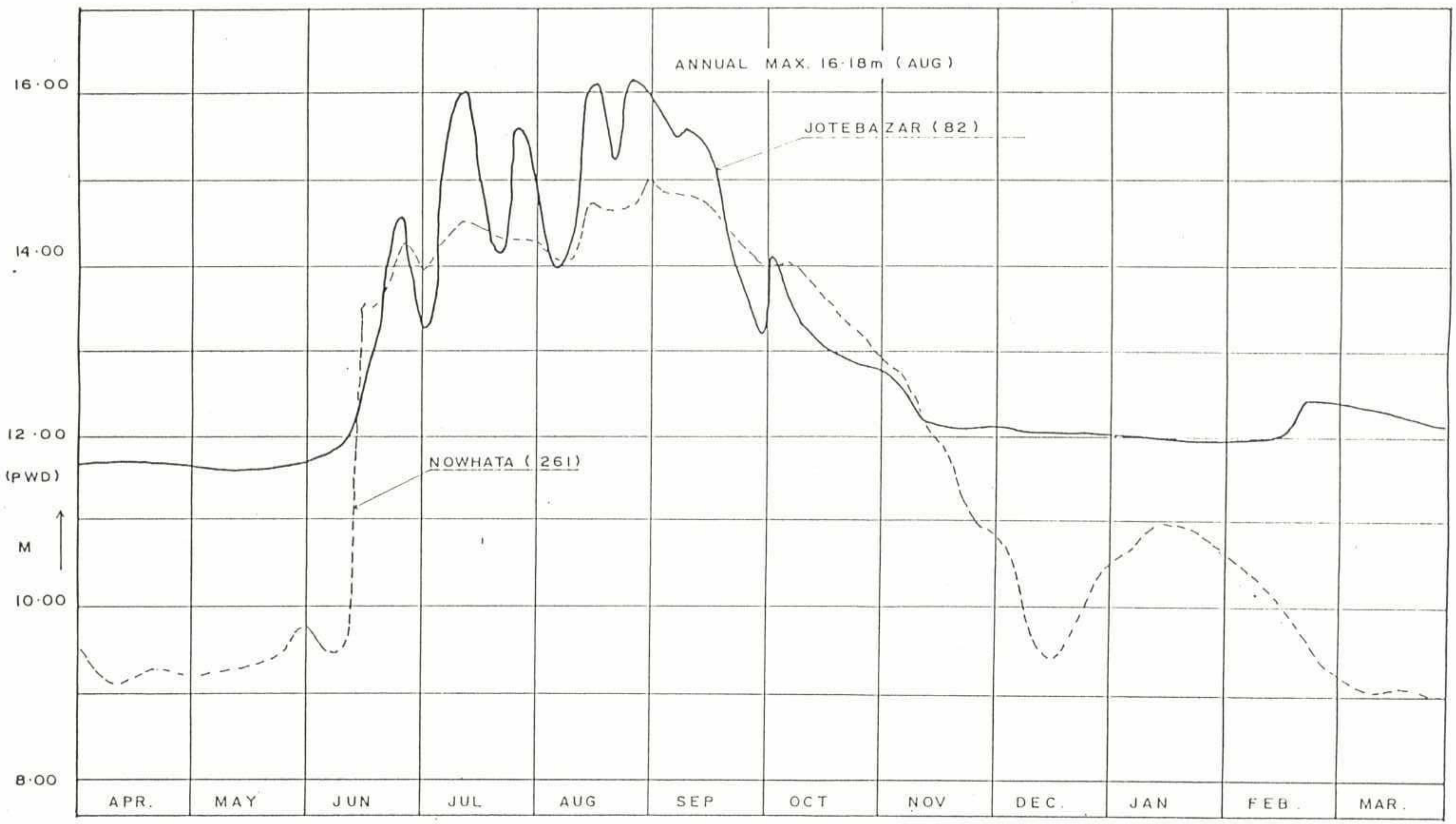


Figure 2.3 Water Level Record (3) (CB - 1988/89)



2.6 ASSESSMENT OF HYDROLOGICAL IMPACT AT THE HOUSEHOLD LEVEL

2.6.1 Introduction

The agricultural module of the PIE farm household survey collected information on the flooding, drainage and irrigation status of the land cultivated by sample households. As such, the survey does not provide information on hydrological changes on land which was not cultivated pre-project (for example, most of the lowest beels) but it is nevertheless an important source of data which permits quantification of hydrological impacts by pre-project land level. The indicators collected were normal flood depth (pre- and post-project), inundation duration (pre- and post-project), and extent and type of irrigation (post-project only).

Table 2.5 Annual Water Level Records
River: Atrai, Station: Jotebazar (82)
Unit: m/PWD

Year	Maximum	Date
1964	13.360	30th July
1965	16.590	1st September
1966	16.200	29th August
1967	16.215	14th July
1968	16.180	25th July
1969	16.335	22nd August
1970	16.390	25th July
1971	16.060	1st July
1972	16.415	2nd August
1973	16.485	18th September
1974	16.500	17th July
1975	16.010	25th July
1976	16.580	17th July
1977	16.190	1st September
1978	16.292	19th July
1979	16.307	28th July
1980	16.307	21st July
1981	16.453	8th July
1982	16.220	14th July
1983	16.580	19th September
1984	-	-
1985	-	-
1986	16.716	10th October
1987	16.400	18th August
1988	16.164	16th August
1989	15.838	22nd July

Source: BWDB records

Table 2.6 Annual Water Level Records
River: Barnai, Station: Nowhata (261)
Unit: m/PWD

Year	Maximum	Date
1964	13.995	3rd August
1965	14.195	1st September
1966	13.610	16th September
1967	-	-
1968	13.845	5th August
1969	14.215	1st October
1970	13.510	4th August
1971	-	-
1972	12.960	9th September
1973	14.400	26th September
1974	14.620	21st August
1975	12.780	30th July
1976	14.265	19th August
1977	13.930	3rd August
1978	13.600	9th August
1979	14.195	18th August
1980	14.432	23rd October
1981	14.448	14th September
1982	13.220	11th August
1983	14.526	13th October
1984	14.510	10th September
1985	14.490	19th September
1986	15.526	8th October
1987	15.336	3rd August
1988	15.134	30th August
1989	14.640	16th July

Source: BWDB records

2.6.2 Impact on Flooding and Drainage

The flood protection embankment, as well as the drainage facilities including regulators and channels provided by the project, have been effective in reducing flood depths and inundation periods at various land levels within the polder. Cultivated lands under different

Table 2.7 Return Periods of Flood by Flood Depth

Return period	Depth at Jotebazar on River Atrai (metres)	Depth at Nowhata on River Atrai (metres)
T (100)	18.76	16.32
T (50)	18.29	15.95
T (20)	17.68	15.47
T (10)	17.22	15.10
T (5)	16.76	14.73
T (2)	16.15	14.24
T (1)	15.68	13.88
1987	16.40	15.34
1988	16.16	15.13

Source: Estimated on the basis of Appendix Tables 2.1 and 2.2.

flood depths and inundation periods in the pre-project and post-project situations are shown in Tables 2.8 and 2.9.

From Tables 2.8 and 2.9 and Figures 2.4 and 2.5, various findings are derived as shown below:

- the cultivated land subject to shallower depths of normal flooding (less than 30 cm.) increased from 21.38 ha. (21.3 per cent) to 38.18 ha. (38.0 per cent) - a positive impact in the protected area. It decreased from 9.22 ha. (69.1 per cent) to 7.85 ha. (58.8 per cent) - a negative impact in the unprotected area, but no significant change was seen in the control area;

- on the other hand, the cultivated land under deeper depths of normal flooding (more than 90 cm.) decreased from 59.53 ha. (59.2 per cent) to 41.56 ha. (41.3 per cent) in the protected area and it slightly increased from 3.50 ha. (26.2 per cent) to 4.13 ha. (30.9 per cent) in the unprotected area. The control area does not show any change as large as in the impacted areas;

- the cultivated land subject to shorter inundation periods (less than one month) increased from 18.80 ha. (18.7 per cent) to 34.32 ha. (34.2 per cent) - a positive impact in the protected area. It decreased by 16 per cent from 8.40 ha. to 7.07 ha. as a disbenefit of the project in the unprotected area. Although the control area shows slight changes in the cultivated lands subject to various inundation periods, they do not seem significant;

- construction of the flood control embankment empoldering the project area, created three types of hydrological impacts on the area outside the project area, viz., (a) raising the flood level, (b) increased drainage congestion and (c) preventing movement of water along routes inside the project;

Table 2.8 Cultivated Land by Flood Depth

(Unit: ha)

Flood Depth	Impacted Area						Control Area		
	Protected Area			Unprotected Area					
	Before	Present	Increase	Before	Present	Increase	Before	Present	Increase
High (%)	12.73 (12.7)	28.16 (28.0)	15.43	6.95 (52.1)	5.45 (40.8)	-1.50	8.13 (23.4)	7.93 (22.9)	-0.20
Medium High (%)	8.65 (8.6)	10.02 (10.0)	1.37	2.27 (17.0)	2.40 (18.0)	0.13	3.37 (9.7)	3.31 (9.5)	-0.06
Medium Low (%)	19.59 (19.5)	20.76 (20.7)	1.17	0.63 (4.7)	1.37 (10.3)	0.74	6.09 (17.5)	6.61 (19.0)	0.52
Low (%)	38.26 (38.1)	23.54 (23.4)	-14.72	1.89 (14.2)	2.52 (18.9)	0.63	10.13 (29.2)	9.54 (27.5)	-0.59
Very Low (%)	21.27 (21.1)	18.02 (17.9)	-3.25	1.61 (12.0)	1.61 (12.0)	-	7.00 (20.2)	7.33 (21.1)	0.33
Total (%)	100.50 (100.0)	100.50 (100.0)	-	13.35 (100.0)	13.35 (100.0)	-	34.72 (100.0)	34.72 (100.0)	-

Note: Flood Depth: High = Never flooded, Medium High = 0 - 30 cm., Medium Low = 30 - 90 cm
Low = 90 - 180 cm., Very Low = over 180 cm.

Source: FAP 12 PIE Household Survey

Table 2.9 Cultivated Land by Inundation

(Unit: ha)

Inundation Duration (months)	Impacted Area						Control Area		
	Protected Area			Unprotected Area					
	Before	Present	Increase	Before	Present	Increase	Before	Present	Increase
0 (%)	15.18 (15.1)	30.13 (30.0)	14.95	8.00 (60.0)	7.07 (53.0)	-0.93	7.93 (22.8)	8.31 (23.9)	0.38
0 - 1 (%)	3.62 (3.6)	4.19 (4.2)	0.57	0.40 (3.0)	- (-)	-0.40	1.22 (3.5)	1.33 (3.8)	0.11
1 - 2 (%)	8.17 (8.1)	6.04 (6.0)	-2.13	- (-)	0.27 (2.0)	0.27	3.84 (11.1)	3.87 (11.2)	0.03
2 - 3 (%)	10.11 (10.1)	9.07 (9.0)	-1.04	0.27 (2.0)	1.34 (10.0)	1.07	3.62 (10.4)	3.54 (10.2)	-0.08
3 - 4 (%)	20.10 (20.0)	17.46 (17.4)	-2.64	0.27 (2.0)	0.27 (2.0)	-	3.26 (9.4)	3.61 (10.4)	0.35
4 - 5 (%)	20.33 (20.2)	14.23 (14.1)	-6.10	1.46 (10.9)	1.46 (10.9)	-	4.97 (14.3)	5.48 (15.8)	0.51
5 - 6 (%)	13.43 (13.4)	10.22 (10.2)	-3.21	1.88 (14.1)	1.41 (10.6)	-0.47	5.88 (17.0)	4.44 (12.8)	-1.44
6 and over (%)	9.56 (9.5)	9.16 (9.1)	-0.40	1.07 (8.0)	1.53 (11.5)	0.46	4.00 (11.5)	4.14 (11.9)	0.14
Total (%)	100.50 (100.0)	100.50 (100.0)	-	13.35 (100.0)	13.35 (100.0)	-	34.72 (100.0)	34.72 (100.0)	-

Source: FAP 12 PIE Household Survey

Figure 2.4 Cultivated Land by Flood Depth.

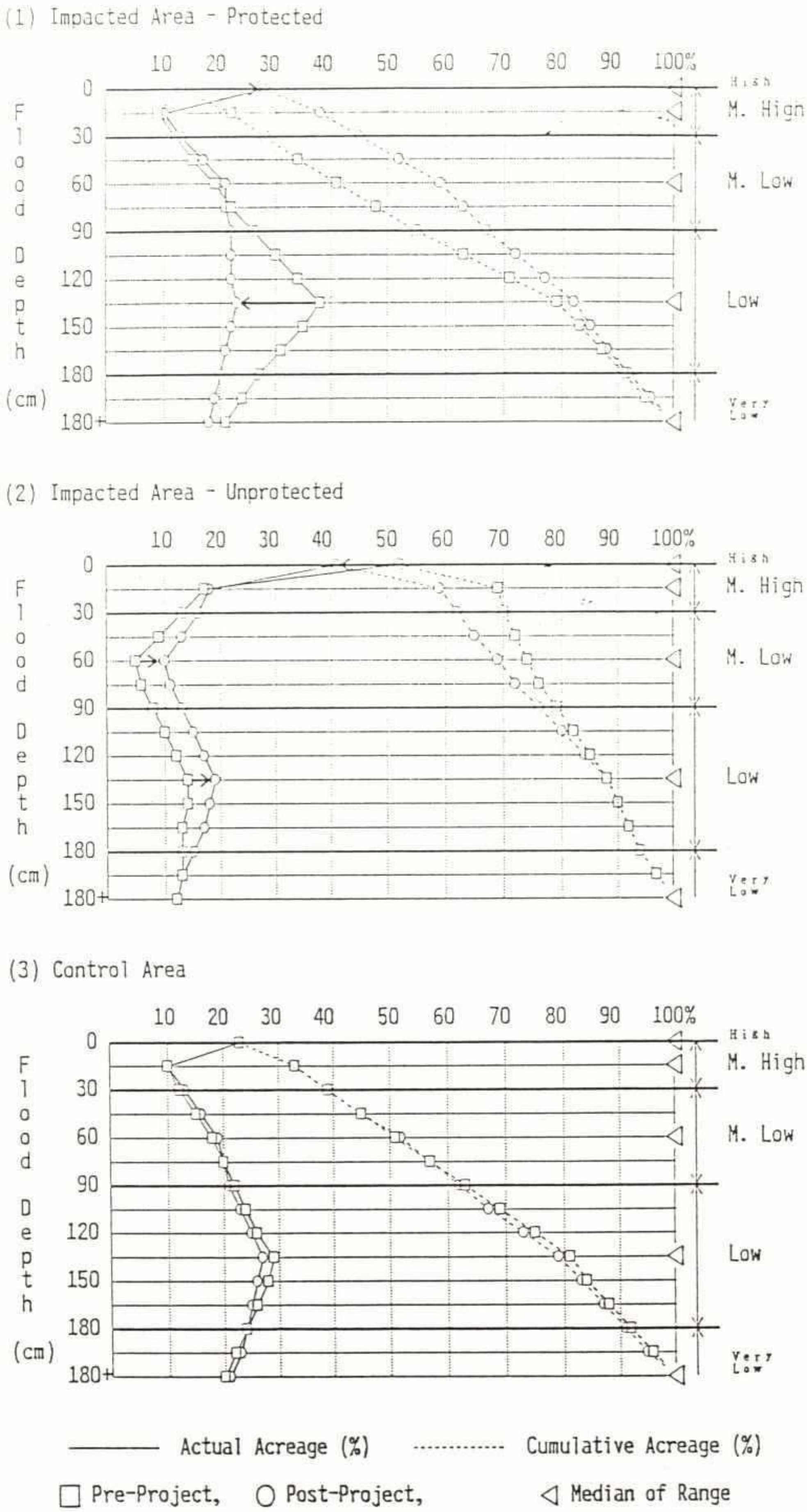
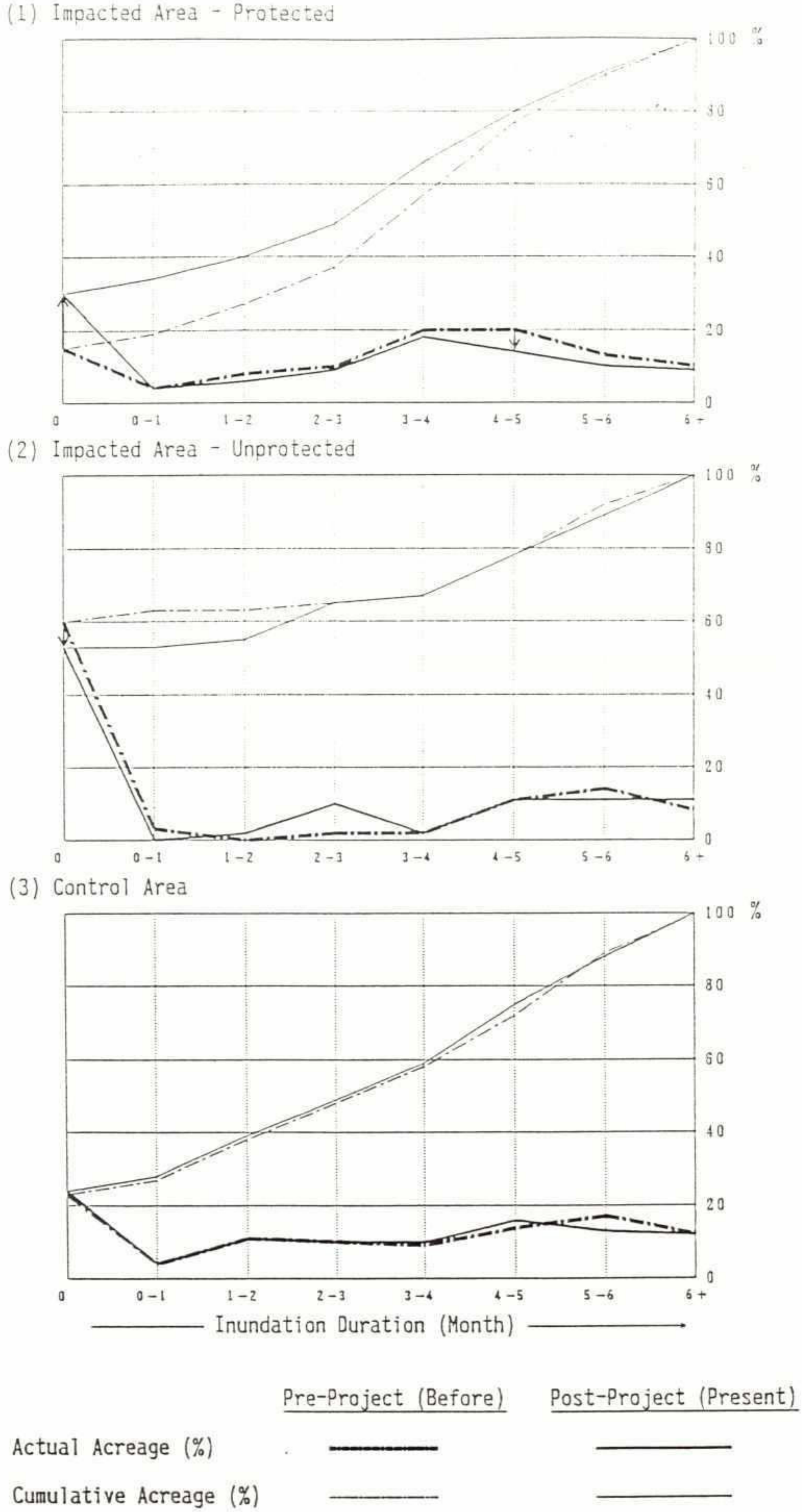


Figure 2.5 Cultivated Land by Inundation Duration.



- the disposal of the flood water of the rivers Atrai, Fakirni, Barnai and Sib remained confined to the area outside the project, causing rise in flood levels. It is seen that the people outside have been subjected to more intense flooding than the people inside the project. This naturally led the people in the periphery to resort to several public cuts, especially 33 cuts and 6 cuts during the 1987 and 1988 floods, respectively;

- the over-all similarity in the pattern of flooding before the Project in the Project and Control areas indicates that the control area had been chosen well.

2.6.3 Impact on Irrigation

The many beels in the project area retain water after the flood waters have been drained to the surrounding rivers. These beels would have as much as one to four feet of water in the beginning of the year. The many natural channels are dry in the period from December to May or June. The surrounding rivers, except the Atrai River, also cease to flow. In the past only traditional irrigation practices were followed by the local farmers in the project area, such as the 'don' and 'heothi' methods. Only plots very near to the beels could be irrigated.

After implementation of the project both the irrigation coverage and the use of modern irrigation equipment such as LLP (with capacity of 1-2 cusec), DTW (2 cusec) and STW (0.5 cusec) have increased. Tables 2.10 and Figure 2.6 give the post-project irrigation condition in the impacted and the control areas, based on which the following findings can be summarized:

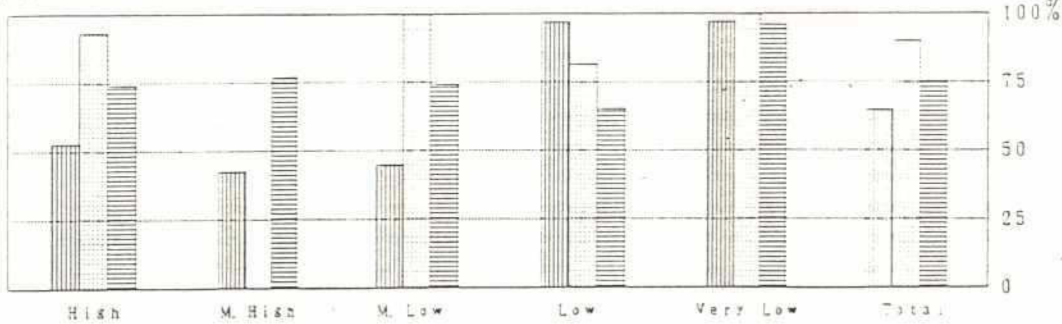
Table 2.10 Irrigated Area by Flood Depth and Crop Season
(Unit ha.)

Crops		Impacted Area												Control Area					
		Protected Area						Unprotected Area											
		H.	M.H.	M.L.	L.	V.L.	Total	H.	M.H.	M.L.	L.	V.L.	Total	H.	M.H.	M.L.	L.	V.L.	Total
Boro	Crp. A	10.84	3.29	9.13	14.18	16.10	53.54	0.18	-	0.40	2.52	1.60	4.70	5.76	1.15	2.77	6.72	6.57	22.97
	Irr. A	9.23	2.59	7.71	13.73	15.61	48.87	0.17	-	0.40	2.05	1.60	4.22	5.18	1.14	2.48	6.55	6.29	21.64
	(%)	(85.1)	(78.7)	(84.4)	(96.8)	(97.0)	(91.3)	(94.4)	-	(100)	(81.3)	(100)	(89.8)	(89.9)	(99.1)	(89.5)	(97.5)	(95.7)	(94.2)
Aman	Crp. A	12.63	6.34	10.39	-	-	29.36	-	-	-	-	-	-	2.47	1.60	1.82	3.66	-	9.55
	Irr. A	2.62	1.53	1.52	-	-	5.67	-	-	-	-	-	-	1.68	1.06	0.77	0.08	-	3.59
	(%)	(20.7)	(24.1)	(14.6)	-	-	(19.3)	-	-	-	-	-	-	(68.0)	(66.3)	(42.3)	(2.2)	-	(37.6)
Aus	Crp. A	2.42	1.89	1.44	-	-	5.75	0.40	-	-	-	-	0.40	3.38	0.48	0.53	0.03	-	4.42
	Irr. A	1.81	0.78	0.17	-	-	2.76	0.37	-	-	-	-	0.37	1.71	0.28	0.53	0.03	-	2.55
	(%)	(74.8)	(41.3)	(11.8)	-	-	(48.0)	(92.5)	-	-	-	-	(92.5)	(50.6)	(58.3)	(100)	(100)	-	(57.7)
Total	Crp. A	25.89	11.52	20.96	14.18	16.10	88.65	0.58	-	0.40	2.52	1.60	5.10	11.61	3.23	5.12	10.41	6.57	36.94
	Irr. A	13.66	4.90	9.40	13.73	15.61	57.30	0.54	-	0.40	2.05	1.60	4.59	8.57	2.48	3.78	6.66	6.29	27.78
	(%)	(52.8)	(42.5)	(44.8)	(96.8)	(97.0)	(64.6)	(93.1)	-	(100)	(81.3)	(100)	(90.0)	(73.8)	(76.8)	(73.8)	(64.0)	(95.7)	(75.2)

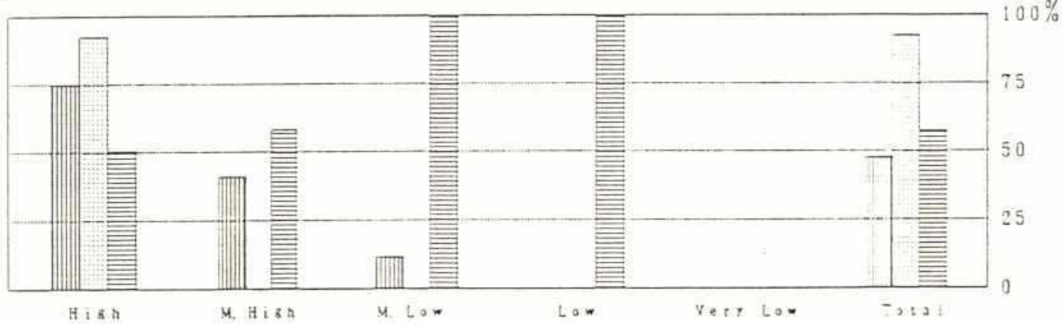
Source: FAP 12 PIE Household Survey
Note: Flood Depth: High = Never flooded, Medium High = 0 - 30 cm., Medium Low = 30 - 90 cm.
Low = 90 - 180 cm., Very Low = over 180 cm.
Crp. A. = Cropped Area, Irr. A. = Irrigated Area

Figure 2.6 Cropped Area under Irrigation by Flood Depth and Season

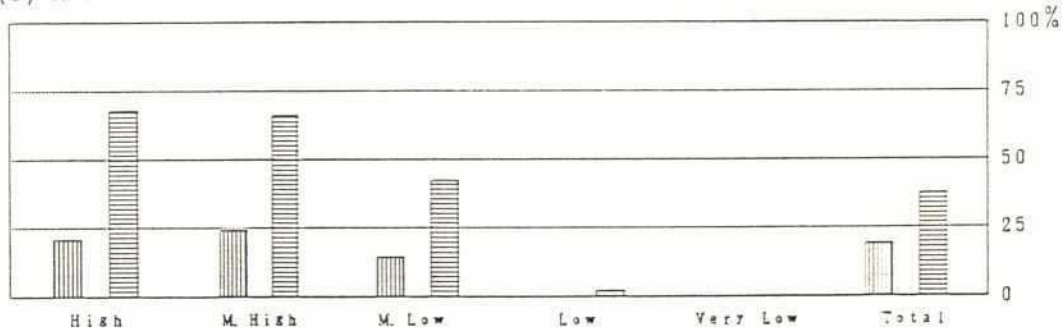
(1) Whole Season



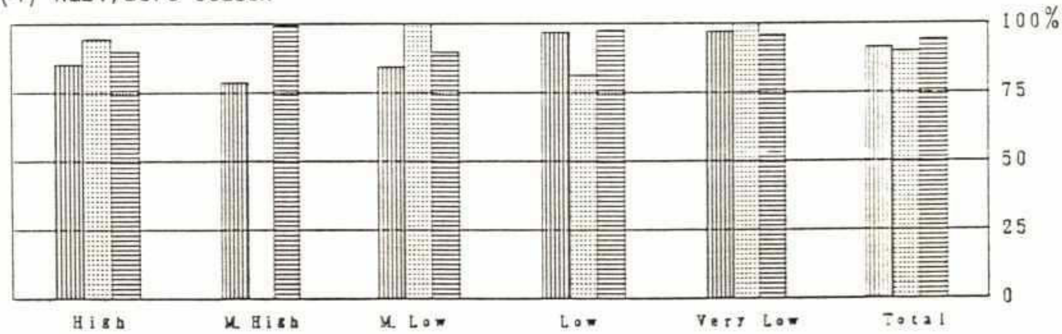
(2) Aus Season



(3) Aman Season



(4) Rabi/Boro Season



	Total Cropped Area (ha)				Legend
	Whole Sea.	Aus	Aman	Rabi/Boro	
Protected	88.65	5.75	29.36	53.54	▥
Unprotected	5.10	0.40	-	4.70	▒
Control	36.94	4.42	9.55	22.97	▤

- irrigation plays a vital role in rabi season crops cultivation, especially HYV Boro: the rabi season occupies 85 per cent and 92 per cent, and 78 per cent of the year-round irrigated area in the impacted/protected and unprotected areas, and the control area respectively; over 90 per cent of the cropped area during the rabi season is usually irrigated in the impacted and the control areas; about 65 per cent and 76 per cent of the total irrigated area and the rabi season irrigated area are HYV Boro in the impacted/protected area; more than 95 per cent of the HYV Boro cultivated area at various flood depths is under irrigation in the impacted and the control area;

- in the impacted/protected area indigenous irrigation methods are predominantly practised, covering 53 per cent of the total irrigated area and 47 per cent of the rabi season irrigated area, followed by shallow tube wells (28 per cent and 26 per cent respectively). Furthermore the indigenous method plays a more important role at very low land levels (flood depth of more than 180 cm.) occupying 73 per cent of the irrigated area. About two-thirds of total irrigated area in the impacted/unprotected area is covered by low-lift pumps and shallow tube wells. Shallow tube wells occupy 64 per cent of total irrigated area in the control area. As such, these data do not indicate a significant project impact on irrigation.

2.7 A SUMMARY VIEW OF PROJECT ACHIEVEMENTS

On the whole the success and failures of the Project can be summed up as follows.

2.7.1 Positive Aspects

- The flood embankment of Chalan Beel Polder 'D' seems adequate to withstand the normal yearly floods caused by the rivers to the empoldered area. The height of the embankment appears to be in conformity with the high water levels recorded in the area.

- The crest width (14 ft.) of the flood embankment seems to be adequate for road traffic (although this width is hardly sufficient for two standard vehicles) to pass and has improved the communication network of the project area.

- The embankment slopes, both on the river side and the country side, are adequate for the stability of the sides, providing better flood prevention, unless the embankment it is cut.

2.7.2 Negative Aspects

- The project has created a drainage congestion problem to the periphery of the Polder.

- The natural water way is confined by the construction of adjacent polders which caused the water level to rise even more, causing further inundation problems to people at some locations.

- Insufficient set back distance at most parts of the project is threatening and in future will threaten the embankment stability and its ability to provide effective protection of the people and crops within the polder.

- Regular repair and rehabilitation work needs to be carried due to the zero set back, and will incur a huge cost.

- The durability of protective works taken up against scouring and wave action remains questionable.

- Reconstruction materials used in some cases for the repair of the embankment in some cases are not suitable for the stability of the earth works;

- The existing Beels and Channels are silted up and creating drainage problems within the polder.

- The roads constructed under FFW the programme are generally without any drainage provision and are creating local drainage problems within the Polder area.

- Rat holes are very common and major reasons further appear to be either compaction with labour-intensive methods or no compaction at all.

2.8 RECOMMENDATIONS

In the light of the discussion in the preceeding sections the following recommendations are made for a better functioning CBPD.

2.8.1 General

- Water conservation facilities should be improved outside the polder.

- Diversion channels should be created to divert water and lessen water pressure. This movement will contribute water to be stored in the natural water conservancy systems.

- Proper coordination and consultation with BWDB must be maintained by other agencies while constructing roads within the project.

- More sophisticated methods such as mechanical compaction should be practised for construction/repair/rehabilitation of major flood embankments to obtain the required degree of compaction.

2.8.2 Specific Recommendations

The problems of public cuts and drainage congestion both inside and outside the polder may be overcome by adopting one or a combination of the following proposals.

8ɓ

a) Re-excavation of Kompo River

Complete renovation (re-excavation) of the Kompo River and construction of regulators with the requisite number of vents both at its off-take near Tangrapara and at the outfall near Birkaya in addition to the existing regulators. The Kompo River would serve to drain the excess Sib River water to the Fakirni River. This river would also work as the main drain for the Project area.

b) Compartmentalization of the Chalan Beel Polder D

The Kompo River could be re-excavated as in (a) to make a link channel between the Sib River and the Fakirni River without constructing any regulator at its off-take or out-fall, but the river would be completely embanked, creating two separate polders (compartments) on the north and south of the Kompo River. The local drainage problems of the compartments might be dealt with by the existing and some additional regulators.

c) Closure/control of Fakirni River at off-take

Complete closure by a cross-dam or control of flow of the Fakirni River by a regulator at its off-take would assist each of the proposals mentioned under (a) and (b) to a great extent, as the present Fakirni River section is not adequate to carry its own discharge from the Atrai River in addition to the expected discharge through the Kompo River, particularly when it is facing a back flow at its confluence with River Barnai, during monsoon. However, the effect of the complete closure of the Fakirni on the Atrai River at Jotebazar on the remainder of the Atrai Basin would have to be studied in detail before taking any firm action.

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3 OPERATION AND MAINTENANCE - INSTITUTIONAL ASPECTS

3.1 PRE-PROJECT SITUATION

Prior to the Project there appears to have been no local popular initiative for flood control, but private irrigation management was long established in the form of irrigation of Boro crops around the receding beels by traditional means. Also tubewells, mainly DTWs had been introduced before the project was implemented, so that the potential for increasing agricultural production through dry season water management was already being taken up.

There was virtually no consultation with local people at the planning stage of the Project. This means that BWDB missed the benefits of local knowledge with respect to local soil type, topography, flood incidence and flood depth, and irrigation and drainage requirements. The apparently inappropriate and inadequate provision of irrigation inlets, drainage outlets and drainage channels in the project may have arisen because of this, although it is far from sure whether local consultation would have revealed the risk of adverse external impacts and the consequent threat to project functioning posed by public cuts.

3.2 INSTITUTIONAL FRAMEWORK

The institutional arrangements for this Project follow the normal BWDB arrangements for O&M. The project falls under the jurisdiction of Rajshahi WD Division Executive Engineer, and is split under two sub-divisions. The Project Proforma (PP) called for Section Officers to be responsible for O&M of 60-70 km reaches of embankment along with the other structures falling within that reach while in each section three Work Assistants should be employed. Although each regulator is supposed to have a khalashi and the PP called for a total of 21 such khalashis, the actual number in post is unclear. However, the intended system of embankment khalashis appears not to be in place. There is no institutional role for local administration or beneficiaries in project management.

It is understood that the project was kept under a non-O&M Division for as long as possible in order to cross-subsidise work on the Project out of other ongoing projects. There is no cost recovery system in the Project even for covering the costs of the limited irrigation infrastructure provided to small well defined client groups. As is usual in FCD/I projects there is very little collaboration between Project officers and the local administration over measures taken which affect water management.

Although an O&M manual was prepared for the Project it was found not to be in use by the two SDEs responsible for O&M of the project. It would appear that drainage facilities cannot operate as intended due to poor maintenance, while the project may also hinder ground water recharge. Integrated reassessment of water management is needed, and should include the implications of private sector irrigation, and of the project on outside areas.

3.3 OPERATION AND WATER MANAGEMENT

3.3.1 Drainage and cuts

Formally operation is restricted to operating Project structures. However, in practice monsoon season water management in the Project affected area involves much more than this and the Project actions may play only a minor role in determining monsoon water levels.

The project has not succeeded in involving local people in the routine operation and maintenance of regulators and drainage outlets. There are no local committees for these structures and they are operated or not operated at the will of local influential persons, some of whom were reported to have taken home some removable components of the control structures.

As a direct result of the project, social conflicts and tensions with respect to public cuts of the embankment, and access of people to the fishing grounds, have intensified. The former involves the impacts of the Project on adjacent outside areas, and the consequences of cuts for monsoon water levels and drainage inside the Project. The major conflict of interest arises during the high flood period along the Sib river. Outsiders become desperate and organize public cuts of the embankment in an attempt to get rid of inundation, while the insiders fearing breaches and cuts do everything possible to protect the embankment. The regular problem of the Tangrahata cut, which takes place almost every year, causes a sudden on-rush of water within the polder and leads to a chain of cuts of the main roads and village roads further down the polder. It finally compels the project insiders to cut the embankment at places such as Madhupur, Mansinhapur and Birkaya along the Fakirni river, to let out the water.

While these problems do not make the water management opportunities created by the Project wholly redundant, they do severely handicap the potential benefit for those parts of the Project most at risk and ultimately make agriculture at least as risky as before if not more so because of the unpredictability of sudden floods.

3.3.2 Irrigation

In areas, where BWDB did not make adequate provision for irrigation inlets, farmers have innovated positively by cutting the embankment in the dry season to make temporary irrigation inlets for HYV Boro cultivation. They close these cuts immediately after their irrigation needs are fulfilled. No doubt, such cuts undermine the strength of the embankment and in turn create a maintenance problem as there may be a higher risk of failure at these points, but they imply that there is a need for pucca irrigation inlets, and that farmers have a responsible attitude to the embankment. Irrigators should bear the costs of their actions, by being required to lay pipes and resection the embankment under BWDB supervision and approval. It also indicates that if structures such as irrigation inlets and drainage outlets are properly designed and constructed, they can benefit many farmers; and that the farmers can organize themselves to operate and maintain irrigation works, provided they see the positive benefits of such actions.

A number of pucca irrigation inlets have been constructed and supplied by the government (BWDB) free of cost, but many of these structures have been taken over by local influential people, who act as the *de facto* owners of these structures. For example, a number of pucca irrigation inlets were constructed by BWDB along the western bank of the Atrai river near Pratappur at the request of a few individuals who have been operating low lift pumps

(LLPs) at these inlet points to sell irrigation water privately for many years. Similar evidence of privatizing BWDB-built modern irrigation inlets with long pucca conveyance channels can be found near Char Laxmipur village along the Atrai river in Naogaon polder. Since these structures are location-specific to lift surface water from the river, these private entrepreneurs operate LLPs in a natural monopoly environment and charge exorbitant prices for water, ranging from Tk 600-1000 per bigha. Such monopoly rent, reaped by private individuals aided by the state provided resources, is a natural candidate for taxation, the proceeds of which could be used to cover operation and maintenance costs.

Hence there are serious institutional issues which will need to be resolved if there is any plan to increase the number of irrigation inlets, or if BWDB is to recover even O&M costs from these facilities and to ensure that the benefits are more equitably distributed.

3.3.3 Use of Project Infrastructure

The borrow-pits along the river sides remain dry for most of the dry period, and therefore there is no significant instance of leasing of borrow-pits for fishery development as envisaged in the project. A limited number of borrow-pit areas which retain some water are leased out together with the adjacent Khas land, but the lease holders are usually the local influential people, not the landless people as expected in the project plan.

Similar problems arise over the use of the beel areas, although it is uncertain whether the Project has contributed to this trend. Farmers who lease in parts of the beels to grow Boro paddy are in conflict with people who lease these beels for fishing. Conflict arises as the farmers dig small ponds after the Boro harvest in the lowest part of their land and put branches of trees in these ponds to be used as fish shelters. This reduces the catch of the fisheries leaseholders because the fish take shelter in these ponds during the fishing time, called **Baich**. The increase in these conflicts has, by implication, increased the demand for official interventions to resolve conflicts, although there are also instances of social interventions to resolve or avoid conflicts.

3.4 MAINTENANCE

Section 2.3 and Table 2.1 have discussed the present condition of the Project infrastructure. Substantial annual expenditures are being made not on routine maintenance but on trying to repair damage or prevent new damage. Ultimately these costs should not be seen as maintenance but as a drain on resources due to problems which should have been foreseen during the planning phase when investments could have been modified to minimise these risks - in particular the conflicts of interest between insiders and outsiders due to the direct impacts of the Project and the risk of wave action where embankments adjoin wide expanses of water for most of the monsoon.

The number of cuts, breaches, and damaged reaches of embankment continues to be high in both high flood years (33 breaches and cuts in 1987) and more normal years (overtopping of the embankment near Karatipara on the Fakirni river and four public cuts in 1991). In 1991 some 40 percent of the embankment was found to be in need of repairs, while BWDB reported that 23 km of drainage channels needed re-excavation.

There is no system of routine maintenance of the embankment or khals, and no direct public involvement in maintenance. However, there is evidence of public willingness to be involved since some people did respond to BWDB's call to voluntarily watch vulnerable sections of the embankment and to help in protecting these with sandbags. This willingness reflects the insider's fears of public cuts. Unfortunately this is on an ad hoc basis and may strengthen social conflicts rather than addressing the underlying problem of external impacts. There is scope for a systematic cooperative emergency management of the embankment in the monsoon season involving local people working on call to protect their reaches of embankment with technical support from BWDB, while in the longer term a routine maintenance system is needed as is a means of compensating outsiders and so preventing cuts.

3.5 COSTS

O&M related costs were obtained from BWDB for the project for 1989-90 and 1990-91, plus the bid for repair works following the 1991 monsoon season. While revenue budget expenditures on structures (embankment, regulators and BWDB buildings) were relatively constant at Tk 0.41 million in 1989-90 and Tk 0.46 million in 1990-91, the figures for establishment (staff) show a large increase during the two years (even including a separate estimate of transport costs in the establishment cost of 1989-90): from Tk 0.19 million in 1989-90 to Tk 0.43 million in 1990-91.

However, as can be seen the vast majority of expenditure is under food for work programmes and for 'flood damage repairs'. During the three years 1988-91 some Tk 52.1 million has reportedly been spent on such repairs and the proposal for winter 1991-92 is even higher than that average. The Project is relatively recent and ought to be in good shape without requiring repairs to regulators or major works on the embankment. Of course the early years of the Project have been marked by exceptional floods, but much of the damage appears to be recurrent and not a result of high floods. It is uncertain whether the Project will in future be able to function with the low level of revenue budget funding or whether it will be perpetually dependent on rehabilitation funds. Moreover repairs and rehabilitation mean that it is not functioning properly and hence the intended benefits are not being achieved (see Chapter 4 for example), bringing into question the long term viability of the Project.

Table 3.1 Reported O&M Costs (financial, current prices)

Heading	Cost (Tk) 1989-90	1990-91	1991-92
Revenue budget (head 163)			
embankment	127736	160282	
regulator	268911	203123	
colony	15788	96033	
establishment	141951	431226	
transport	51167	0	
food for work related	28639	131032	
	-------	-------	
Total	634192	1021696	
Food-for-Work			
metric tonnes	446	910.5	1795[1]
cost (1991 financial prices based on FPCO, 1991 and 10% pa inflation)	3340000	6810000	13430000
Flood damage repair costs rehabilitation/resectioning and bank protection works			34680000

Note: 1 1991-92 figure is BWDB request for repair work following 1991 monsoon season as detailed in Rajshahi WD Division Flood Damage Information dated 14.10.91

Source: BWDB unpublished data

3.6 CONCLUSIONS

Normal or routine operation and maintenance of this Project are hardly being carried out since there is little opportunity for this. The problems of raised water levels outside the Polder, cuts and breaches and internal flooding and drainage congestion all result in continual damage to the embankment and make the chances to operate the regulators to any effect more limited than they would otherwise be. However, the small scale irrigation improvements do appear to function successfully. Ultimately O&M has been handicapped by the planning and implementation of the Project, specifically:

- constriction of the external waterways and floodplain, with adverse impacts on people outside the Project;

- insufficient setback distance of the embankment from the rivers resulting in damage and hence higher repair and embankment protection costs;

- inadequate/poor quality repair works resulting in further damage in subsequent years and hence further needs for damage repairs; and

- drainage congestion resulting from a mixture of limitations on gravity drainage, public cuts and flooding from outside and poor maintenance of the drainage khals.

There is an urgent need to rectify some of these problems and at the same time to actively involve local people in the Project. If the Project can provide tangible benefits to people then there will be an incentive for them to participate in regulator and irrigation committees/groups although this will require the support of social organisers. Improved operation is contingent on preventing cuts by outsiders. This will require measures to compensate them or new engineering works to reduce external flood levels (essentially by reducing the benefited area so that flood storage is created and water can flow out more freely, see Chapter 2).

O&M can assist this by offering benefits to outsiders in the form of homestead land on the embankment or on inside land, and use of the embankment - for example for social forestry. It might even be possible for disadvantaged groups to manage the irrigation inlets and hence earn an income rather than the powerful local interests at present. However it would require considerable political will and support from the local administration to take back this control from the local elites. Repair and rehabilitation does direct employment to the landless; but a system of routine maintenance, which might also prevent damage to crops and property and direct benefits to the disadvantaged (landless and poor women for example), would be preferable.

4 AGRICULTURE

4.1 INTRODUCTION

The Chalan Beel Polder - D project is situated in the UNDP/FAO Agro-ecological Regions "High Ganges River Flood Plain" and "Tista Flood Plain", in Rajshahi and Noagaon districts. Both flood plains have a complex relief of broad and narrow ridges and inter-ridge depressions, separated by areas with smooth, broad ridges and basins. The upper parts of high ridges belong to "highland" while the lower parts of ridges and basin margins are mostly classified as "medium high land". The basin centres are below R.L. 12.2 m and classified as "lowland" locally known as beels, some of which remain inundated even in the dry season. The "Tista Flood Plain" characterises the upper part of the project where the soil type is calcareous and the "High Ganges River Flood Plain" characterises the lower part where the soil is mostly coarse with low organic matter and low moisture holding capacity. Ground water is available at between 60-75 meters depth.

The project area is situated in one of the hottest parts of the country. During the dry season the rivers dry up. The annual average rainfall is about 1400 mm which is less than that in the other regions. The Rabi season temperature varies from 10-25°C. This temperature range is moderately suitable for wheat, potato, mustard and lentil cultivation but not so good for HYV Boro cultivation which needs a higher temperature during the vegetative growth period.

The Chalan Beel project area was a regular monsoon flooding area in the pre-project period. The pre-project area under different flood levels is shown in Table 2.4 High flood levels during monsoon season in the rivers Atrai, Fakirni, Barnai and Sib, caused extensive damage to standing Aus and Aman crops.

The embankment now stops surface water from entering the poldered area and restricts free drainage of water inside. Intensive rainfall for a short time causes drainage congestion and creates heavy pressure on drainage structures. During the monsoon, heavy water pressure causes certain sections of the embankment to be weakened. These sections erode, due to lack of proper maintenance and breaches occur frequently. On the other hand, residents in the adjacent area suffer from heavy flooding and they cut the embankment to reduce the water depth and to save their crops and property. In the absence of appropriate resectioning and reconstruction of the embankment, the project may fail to provide adequate flood protection and this in turn may not lead to significant change in agricultural production.

Before the project farmers in the project adjusted their cropping pattern to the regular flooding. Broadcast Aman (49.4 per cent of the gross cropped area) and local Boro (33.9 per cent of the gross cropped area) were the major crops in the low-lying areas. The single cropped area was about 28 per cent (Feasibility Report 1979). The diffusion of HYV Boro area was low (5.1 per cent of the gross cropped land). Only the low lands (9 per cent of gross project area) were extensively cultivated. The cropping intensity was about 157 per cent in the pre-project situation and was expected to increase to 235 per cent at full development after Project completion (Feasibility Report).

The average yield of paddy crops in the project area was about 1.4 tons per hectare in the pre-project situation. The yield of other major crops, wheat, pulses, oilseeds and jute were 1.6, 0.92, 0.46, and 1.2 tons per hectare respectively.

Input use in the pre-project situation was very low. This may have been due to the uncertainty in crop production and low returns and the almost total absence of input-intensive HYV crops. Crop management practices were higher in B. Aman and Boro LV, compared to other crops. Traditional methods of post harvest operations were practised in the project area.

The main problem in the project area, pre-project, was monsoon flooding and dry season drought. The cropping patterns were adjusted to the flooding pattern. Floods lowered crop yields as well as production. Extension of the HYV area had not occurred due to high flood risk and input-use remained low both due to the flood risks and low diffusion of HYVs.

4.2 PROJECT OBJECTIVES

The objectives of the CBPD were to provide flood protection and drainage improvement which were supposed to benefit the agricultural farm land and thereby increase agricultural production through increased crop yields and cropping intensities. In addition, facilities for irrigation (inlets) were to be provided on a limited scale near the surface water sources in the dry season to cope with the drought and/or soil moisture stress. Improvement of cropping pattern through timely sowing/planting after the earlier recession of flood water was another target of the project.

4.3 EXPECTED BENEFITS

The expected benefits of the project were:

- reduced flood damage and risk of crop failure;
- expansion of Boro HYV area;
- expansion of Rabi crop area;
- shift from B. Aus and B. Aman, and T. Aus to T. Aman and from local to high yielding varieties;
- ensured supply of irrigation water,
- change in cropping intensity from 157 per cent to 235 per cent; and
- increase in paddy yield (by 49 per cent from 1.4 mt to 2.09 mt per ha) and production (by 56 per cent from 87299 mt to 135835 mt).

4.4 CROPS, CROPPING PATTERN AND CROPPING INTENSITY

4.4.1 Cropped Area

The section on hydrology has shown how the inundation status of the cultivable land in sample households at various locations has changed over time. To reiterate, it has been found that the distributions of such land by flood depth have been fairly similar in the protected (project) and control areas. The project resulted in a change towards lower inundation depths particularly in the less flood-prone plots. As a result, the distribution of cultivable land by inundation level has become practically the same in the two areas. For a better comprehension the present distributions of the cultivable area by flood depth by protection status are shown in Table 4.1. It is clear from the table that despite a change for the better, there is not such a difference between the protected and the control areas.

Table 4.1 Distribution of Cultivable Area (ha) by Land Level and Protection Status

Land level	Protected		Unprotected		Impacted		Control	
High (HL)	28.2	(28.1)	5.5	(41.0)	33.7	(29.6)	7.9	(22.8)
Medium High (MH)	10.0	(9.9)	2.4	(17.9)	12.4	(10.9)	3.3	(9.5)
Medium Low (ML)	20.8	(20.7)	1.4	(10.4)	22.2	(19.4)	6.6	(19.0)
Low Land (LL)	23.5	(23.3)	2.5	(18.9)	26.0	(22.8)	9.5	(27.4)
Very Low (VL)	18.0	(17.9)	1.6	(11.9)	19.6	(17.2)	7.3	(21.0)
All	100.5		13.4		113.9		34.7	

Source: FAP-12 PIE Household Survey.

Note: Figures in parentheses are percentages of cultivable area (column totals).

The total cultivable area in the sampled farm households in the Project (protected) area is just over one hundred ha. In no season, is all of it actually cultivated. Just about one-half or slightly more is cultivated during Aman and Rabi seasons the latter claiming the higher percentage (Table 4.2). Cultivation during the Aus season is of the least importance. If sample households from the unprotected areas are added to those from the protected area the picture for the impacted area as a whole remains unaltered.

The seasonal pattern of land utilisation is quite similar in the control area with somewhat more emphasis on Aus and the Rabi Season.

4.4.2 Cropping Pattern

There is no major difference in cropping pattern between the impacted and control areas in the sense that both are heavily dependent on cultivation of paddy. Although the control area appears somewhat more given to cultivation of non-paddy crops, considering foodgrains (rice and wheat), there is hardly any difference between the two (Table 4.3). The only substantial difference is seen in the land area used for local transplanted Aman. A substantially larger proportion of the impacted area was under LT Aman, but this was partly offset by a higher proportion of area of HYV T. Aman in the control area.

Table 4.2 Distribution of Cropped Area by Season and Protection Status (area in ha. and % of area cropped).

Season	Protected	Unprotected	Impacted	Control
Aus	19.2 (19.1)	2.1 (15.6)	21.3 (18.7)	9.3 (26.7)
Aman	50.5 (50.3)	8.6 (64.3)	59.1 (51.9)	16.2 (46.7)
Rabi	55.0 (54.7)	4.7 (35.2)	59.7 (52.4)	23.8 (68.6)
All (cropping intensities)	124.7 (124.1)	15.4 (114.9)	140.1 (123.0)	49.3 (142.1)
Cultivable Area	100.5	13.4	113.9	34.7

Source : FAP 12 PIE Household Survey
Note: Figures in parentheses are percentages of total cultivable area shown in last row.

Table 4.3 **Cropping Pattern by Protection Status**

(% of gross cropped area)

Crop	Protected	Unprotected	Impacted	Control
Aus Season	9.7	13.9	9.1	10.3
B. Aus, LV	6.9	5.3	6.7	5.2
T. Aus, LV	0.9	-	0.8	0.6
T. Aus, HYV	1.9	8.6	1.6	3.5
Aus/Aman (mixed)	-	-	-	1.0
Aman Season	38.8	55.7	40.7	28.9
B. Aman, LV	15.4	-	13.7	14.2
T. Aman, LV	21.1	55.7	23.9	4.8
T. Aman, HYV	2.3	-	2.1	9.9
Rabi Season	32.8	29.2	32.4	30.8
Boro LV	2.7	3.4	2.7	1.5
Boro HYV	30.1	25.8	29.7	29.3
All Paddies	81.3	98.8	82.2	70.1
Wheat	4.2	-	3.7	9.7
Jute	3.1	-	2.8	3.5
Betel leaf	5.3	-	4.8	6.8
All others	6.1	1.2	6.5	9.9
All	100.0	100.0	100.0	100.0
Gross Cropped land (ha)	124.70	15.43	140.13	49.28

Source: FAP-12 PIE Household Survey.

Inundation of land is a major factor in the availability of land for cultivation. On the other hand during the Rabi season, unless irrigation facilities are available, moisture stress may not allow all the land to be put under cultivation. In general, therefore, low-lying areas are less likely to be cultivated during the Aus season as the growth period of Aus paddies coincides with the peak monsoon flood. If Aus paddies are cultivated, these are likely to be confined to higher grounds. The opposite is likely to happen during the Rabi period when much of the low-land is likely to be under Boro paddy to take advantage of residual moisture in the soil.

As Table 4.4 shows this is indeed what is happening but there appears to be no neat level to crop correspondence. In fact, the lack of correspondence is probably more acute in the protected area.

Concentrating only on B. Aman and Boro HYVs, because these are the crops which are cultivated on a substantial proportion of land in both the areas, one finds that in both cases, control area farmers cultivate them on comparatively low-lying areas. In the protected area, however, land at all levels, particularly high lands are also used for their cultivation. Such behaviour can possibly be explained by the uncertainty regarding public cuts/breaches and inundation in the protected areas.

Table 4.4 Distribution of Area of Selected Paddy Crops by Level of Land

Crop	Area Type	Total Area (ha)	Land Level (% of total area)				
			HL	MH	ML	LL	VL
B. Aus, LV	Protected	8.6	32.3	11.8	32.3	23.5	-
	Control	2.6	17.3	-	78.9	3.8	-
B. Aman, LV	Protected	19.2	21.4	1.3	25.3	37.8	14.9
	Control	7.0	4.2	-	20.4	52.1	23.2
T. Aman, LV	Protected	26.3	40.3	22.3	30.3	6.2	0.9
	Unprotected	8.6	48.6	28.0	16.0	7.4	-
	Control	2.4	35.4	16.7	14.6	22.9	10.4
T. Aman, HYV	Protected	2.9	-	17.4	82.6	-	-
	Control	4.9	21.2	33.3	37.4	8.1	-
Boro, HYV	Protected	37.6	14.9	3.0	15.0	28.6	38.5
	Unprotected	4.0	-	-	10.1	63.2	26.7
	Control	14.5	3.1	0.3	13.0	44.0	39.6

Source: FAP-12 PIE Household Survey.

4.4.3 Cropping Intensity

In the study year there was a substantially lower cropping intensity in the impacted area, compared to the control (Table 4.2). This may be the result of uncertainties regarding public cuts and breaches in the embankment resulting in flood damage in the project area.

4.4.4 Diffusion of HYV Paddy

Table 4.5 shows the diffusion of HYV paddy in the impacted and control areas. From the table it is evident that HYV paddy cultivation is less extensive in the impacted area in all the seasons except Boro. HYV Boro occupies about 8 per cent more of the cultivated land in the project than in the control area, whereas, HYV Aman cultivation is low in the impacted area. As HYV paddy needs more modern inputs such as fertilizer, pesticides and irrigation, the farmers in the impacted area may not feel secure in spending that much as uncertainties still remain regarding flood in the project area due to breaches and public cuts.

Table 4.5 HYV Paddy Diffusion by Season

Crop season		Impacted				Control	
		Protected		Unprotected			
		% of cultivated land in the season	% of Gross cropped land	% of cultivated land in the season	% of Gross cropped land	% of cultivated land in the season	% of Gross cropped land
Aus		12.1	1.9	62.2	8.6	18.7	3.5
Aman		5.7	2.3	-	-	30.0	9.9
Boro		68.4	30.2	84.9	25.9	60.7	29.3
All seasons	%		34.3		34.5		42.7
	ha.		124.7		15.4		49.3

Source: FAP - 12 PIE Household Survey

4.5 CROP YIELDS

Increase in average weighted yield usually arises from three factors: a switch to transplanted varieties and/or HYVs, increased use of crop production inputs and reduced flood loss. None of these three conditions have been fulfilled in the Chalan Beel Polder D, as a result of which the difference in yield between the impacted and the control area is not substantial.

Per hectare yields of paddy are shown in Table 4.6 by individual crop and by land level. Looking first at the weighted average yield one finds that while these are the same in the protected and unprotected areas, the control area weighted yield is somewhat lower, by just about 10 per cent.

Table 4.6 Per Hectare Yield (Metric ton/ha) of Paddy by Land Levels (Study Year).

Paddy	Impacted												Control					
	Protected						Unprotected											
	HL	MH	ML	LL	VL	Total	HL	MH	ML	LL	VL	Total	HL	MH	ML	LL	VL	Total
B. Aus, LV	1.61	2.97	2.16	1.67	0.56	1.94	2.26	-	-	-	-	2.26	1.53	-	1.78	1.54	-	1.72
T. Aus, LV	1.99	2.59	3.94	2.51	-	2.74	-	-	-	-	-	-	2.76	-	1.79	-	-	2.30
T. Aus, HYV	3.21	3.36	3.60	-	-	3.47	3.72	3.63	3.87	-	-	3.39	2.97	3.05	3.56	3.46	1.57	3.05
B. Aus/Aman Mixed	-	-	-	-			-	-	-	-	-		-	1.68	1.68	-	-	1.68
B. Aman LV	1.56	2.19	2.66	1.23	0.76	1.60	-	-	-	-	-		1.45	-	0.85	0.65	1.47	0.92
T. Aman LV	2.15	2.38	2.32	1.96	1.67	2.23	2.77	2.40	1.28	2.22	-	2.39	2.97	1.20	0.56	2.53	1.32	2.04
T. Aman HYV	-	4.11	3.75	-	-	3.80	-	-	-	-	-	-	4.0	2.74	2.91	3.38	-	3.11
Monsoon paddy sub total	-	-	-	-	-	2.12	-	-	-	-	-	-	-	-	-	-	-	1.95
Boro LV	2.30	-	-	1.59	2.14	1.83	-	-	-	-	2.02	2.02	-	-	-	2.04	2.87	2.48
Boro HYV	5.00	4.56	4.50	4.58	4.15	4.47	-	-	4.79	4.62	3.20	4.26	4.12	2.88	4.98	4.42	4.14	3.69
Weighted Avg. Yield (tons/ha.)	2.68	2.38	2.71	2.88	3.44	2.98	2.76	2.62	2.40	4.14	2.18	2.57	3.09	2.52	2.60	2.87	3.41	2.69

Source: FAP - 12 PIE Household Survey

Earlier it has been shown that while there is a higher proportion of land under T. Aman LV in the protected area, this is partly offset by the higher diffusion of HYVs during Aman season in the control area and that the two areas are similar in respect of other crops. It has also been found that in the study year the control area suffered more than its usual 'quota' of crop damages. Some 45 per cent of the paddy land suffered some damage in the control area compared to less than 20 per cent in the protected. If one then uses only these plots which have yielded normal output, the relationship is reversed as may be seen from Table 4.7.

Table 4.7 Per Hectare Yield (metric ton/ha) of Paddy in "Normal" Year.

Crops	Yield (mt/ha)	
	Impacted Area	Control Area
B. Aus LV	2.09	1.83
T. Aus LV	2.87	2.30
T. Aus HYV	3.56	3.73
B.Aus/Aman, Mixed	-	1.68
B. Aman LV	2.14	2.0
T. Aman LV	2.31	2.67
T. Aman HYV	4.06	3.56
Monsoon Paddy Sub total	2.37	2.62
Boro LV	2.45	2.31
Boro HYV	4.61	4.61
All Paddy	**3.2**	**3.45**

Source: FAP-12 PIE Household Survey.

From the Table 4.6 it is evident that there is a little difference in per hectare yield rate of the monsoon paddy (2.12 mt/ha and 1.95 mt/ha) during the study year but during the "normal" year the yield rate is higher in the control area. This is explained by the uncertain flood situation in the project area, due to breaches and public cuts in the embankment. The picture remains unchanged if Boro paddy yields are included in the estimates.

The above results may be seen as surprising as the average paddy yield in the project area has increased from 1.4 mt/ha in the pre-project to 2.98 mt/ha in the post-project in the study year. What these figures actually mean is that the project may have had an impact. But the yields could have increased in any case (due to diffusion of Boro HYVs) even if there had been no project. Also note that the flood uncertainties still persist and may have hindered further improvement in the Project area.

Among the non-paddy crops, yields of jute, chili, wheat, potato, pulses and oilseeds are similar in both impacted and control areas (Table 4.8) reflecting little or no impact of the project on the yields. But, there is enormous difference in per hectare yield of sugarcane (28.89 mt./ha.), and winter vegetables (10.2 mt./ha.) between the impacted and control areas. However, these crops were cultivated in small areas and contribute very little to the total crop output.

Table 4.8 Per Hectare Yield of Non-Paddy Crops by Land Levels

(metric tons/ha)

Crops	Impacted												Control					
	Protected						Unprotected											
	HL	MH	ML	LL	VL	Avg. Yield	HL	MH	ML	LL	VL	Avg. Yield	HL	MH	ML	LL	VI	Avg. yield
Wheat	2.03	2.49	1.83	1.93	1.15	1.98							1.83	1.78	1.73		2.09	1.84
Jute	1.89	1.00	1.62	1.15	1.06	1.62							1.89	1.00	1.62	1.15	1.29	0.93
Betel leaf (Pon/ha.)[1]	14354	18969	-	-	-	16290							14619					14619
Potato	9.22	12.08	13.04	10.09	-	10.96	11.18	-	-	-	-	11.18	9.82	13.97	-	-	-	11.62
Pulse	0.30	0.65	0.36	5.47	-	1.07							0.57	2.30	0.68	-	-	0.93
Oilseed	1.29	-	0.84	0.31	1.19	1.19							0.96	0.04	-	-	-	0.83
Chilli	5.33	0.92	0.51	1.89	0.59	3.08							3.61	-	-	-	-	3.61
Onion/Garlic	8.71	4.42	1.08	7.78	5.53	6.60							7.50	-	9.22	-	-	8.13
Sugarcane	-	30.73	-	-	-	30.73	1.84	-	-	-	-	1.84	1.84	-	-	-	-	1.84
Summer Vegetables	-	-	3.07	-	-	3.07							7.68	-	-	-	-	7.68
Winter Vegetables	27.94	19.41	0.46	5.53	-	23.04							16.94	4.47	-	-	-	12.84
Sweet Potato	-	7.07	-	-	-	7.07							-	-	-	-	-	-
Others	1.08	-	-	-	-	1.08							4.77	-	-	-	-	4.77

Source: FAP - 12 PIE Household Survey
Note: [1]Pon = 80 leaves

4.6 CROP PRODUCTION AND OUTPUT

The estimated outputs for different types of paddy are shown in Table 4.9. For clarity of comparison the cropped areas under paddy in each season are also given alongside. The table clearly indicates that there had been only a little, if any, difference between the two areas in the study year either in distribution of area or of total output by season. It also shows, as is generally the case now in Bangladesh, that the contribution of Boro, (particularly Boro HYVs as practically all such land are sown with HYVs, table 4.10), is the most important in both areas, just about 60 per cent. One may reiterate here that output during the Boro season has little to do with flood protection and more to the spread of minor irrigation.

Table 4.9 Paddy Area and Output in CBPD by Season

Paddy	Protected		Control	
	Area (ha)	Output (mt)	Area (ha)	Output (mt)
Aus	12.12 (11.9)	27.98 (9.2)	4.71 (13.7)	10.58 (11.5)
Aman	48.31 (47.6)	100.12 (33.1)	14.30 (41.8)	26.52 (28.7)
Boro	40.98 (40.4)	174.29 (57.6)	15.20 (44.4)	55.18 (59.8)
All	101.41	302.39	34.21	92.28

Source: FAP-12 PIE Household Survey.

Note : Figures in parentheses are percentages of respective column totals.

Table 4.10 Output in CBPD by Individual Paddies

Paddy	Impacted						Control		
	Protected			Unprotected					
	Cultivated area (ha.)	Total output (mt.)	Yield/ha (mt.)	Cultivated land area (ha.)	Total output (mt.)	Yield/ha. (mt.)	Cultivated land area (ha.)	Total output (mt.)	Yield/ha. (mt.)
B. Aus LV	8.63	16.74	1.94	0.81	1.83	2.26	2.55	4.39	1.72
T. Aus LV	1.18	3.23	2.74	-	-	-	0.30	0.69	2.30
T. Aus HYV	2.31	8.01	3.47	1.33	4.51	3.39	1.73	5.28	3.05
B Aus/Aman Mixed	-	-	-	-	-	-	0.13	0.22	1.68
B. Aman LV	19.19	30.70	1.60	-	-	-	7.02	6.46	0.92
T. Aman LV	26.26	58.56	2.23	8.59	20.53	2.39	2.41	4.92	2.04
T. Aman HYV	2.86	10.86	3.80	-	-	-	4.87	15.14	3.11
Monsoon Paddy sub total	60.43	128.10	2.12	10.73	26.87	2.50	19.01	37.10	1.95
Boro LV	3.37	6.17	1.83	3.05	6.16	2.02	0.75	1.86	2.48
Boro HYV	37.61	168.12	4.47	1.47	6.26	4.26	14.45	53.32	3.69
Total (Sample area)	101.41	302.39	2.98	15.25	39.29	2.57	34.21	92.28	2.69

Source: FAP - 12 PIE Household Survey

Earlier the difference in the cultivation of HYVs during the Aman season between the protected and control areas has been noted. As asserted, the higher proportion of T. Aman LV area in the protected area is compensated for by the higher proportion of area under HYVs in the control area. As Table 4.10 indicates, however, the lower yield in the control area could not fully compensate for the difference in the proportion of area under HYVs. Indeed, in most cases, most noticeably in T. Aman and Boro HYVs, the control area yields are much lower than in the impacted area . On probing it has been found that the control area farms suffered more than usual damages in the study year. Had it not been so, the control area yields would have been somewhat higher there as discussed earlier.

Table 4.11 Non-Paddy Crops and Output

Non-Paddy crops	Impacted						Control		
	Protected			Unprotected					
	Cultivated land area (ha.)	Total output (mt.)	Yield/ha (mt.)	Cultivated land area (ha.)	Total output (mt.)	Yield/ha. (mt.)	Cultivated land area (ha.)	Total output (mt.)	Yield/ha. (mt.)
Wheat	5.22	10.33	1.98				4.75	8.74	1.84
Jute	3.85	6.24	1.62				1.75	1.63	0.93
Betel leaf (Pon[1] ha.)	2.31	37630.82	16290.40				1.12	16373.55	14619.24
Potato	2.15	21.70	10.09	0.18	2.01	11.18	0.46	5.34	11.62
Pulses	1.00	1.07	1.07				0.66	0.61	0.93
Oilseeds	0.78	0.93	1.19				0.31	0.26	0.83
Chilli	0.69	2.12	3.08				0.24	0.87	3.61
Onion/Garlic	0.54	3.56	6.60				0.35	2.84	8.13
Summer Vegetable	0.52	1.60	3.07				0.14	1.07	7.68
Winter Vegetable	0.40	9.22	23.04				0.40	5.14	12.04
Sweet Potato	0.40	0.26	0.65	-	-	-	-	-	-
Sugarcane	0.06	1.84	30.73	-	-	-	0.06	0.11	1.84
Others	0.16	0.17	1.08				1.75	8.35	4.77

Source: FAP - 12 PIE Household Survey

Note: [1]Pon = 80 leaves

Non-paddy output is not substantial in the project area (Table 4.11) as the area under these crops is very small. Yield differences are also low for the major non-paddy crops between the impacted and the control areas.

4.7 CROP PRODUCTION INPUTS

The basic hypothesis regarding input use in the post-project situation is firstly that it would in general rise due to a possible shift from broadcast to transplanted local or from transplanted local to transplanted HYVs and secondly because of lower flood risk it is likely that even in case of less input-intensive crops, input use will increase. This will apply particularly in the case of purchased inputs such as fertilizer. Note, however, that flood risk is just one of the many factors that influenced input use. Hence, a difference or its absence cannot clearly be related to lower or higher flood risk by looking at data for just one year.

Tables 4.12 - 4.13 show the physical levels of input use in paddy and non-paddy crops. Let us first compare the per ha use of inputs. One is immediately struck by the almost total lack of difference in input use pattern except for irrigation water. Irrigation water is more costly on the average in the control area because of much higher dependence on mechanical irrigation in the latter case. In any case, on the whole there had been little difference in the technique of production in the two areas.

A more interesting comparison is perhaps that between the protected and the unprotected zones in the overall impacted area. As T. Aman LV is a major crop in both the zones, one may use the input use in this crop for illustration. One immediately notices an apparently almost 'perverse' situation. Although in all other cases the input use is similar, fertilizer (and manure) are used in much greater (nearly 40 per cent in case of fertilizer) quantity in the unprotected farms. On the other hand about 30 per cent more labour is used in the protected area compared to the control. The lower use of fertilizer may well be, at least in part, a reflection of the still lingering uncertainties in the project area whereas the risks are better known in the unprotected area.

The farmers in the protected area may have used more labour in order to compensate for the lower use of fertilizer. Note that there is little yield difference in T. Aman LV between the two areas indicating that the substitution between the two types of inputs has been done effectively (at the margin).

Table 4.12 Per Hectare Use of Production Inputs: Paddy Crops
(per hectare)

Area characteristics	Paddy	Seeds/ seedlings (Tk.)	Human labour (No.)	Animal labour (No.)	Fertilizer (kg.)	Manure (md)	Pesticide (kg.)	Irrigation water (Tk.)
Impacted protected	B. Aus LV	660.80	127.60	29.49	94.87	44.73	0.29	0.00
	T. Aus LV	693.11	185.25	38.71	162.15	46.21	2.15	152.89
	T. Aus HYV	698.17	181.77	39.59	208.69	30.21	1.08	189.30
	B. Aman LV	604.73	93.19	29.22	47.65	19.56	0.97	0.00
	T. Aman LV	586.55	133.70	35.80	175.71	26.43	0.90	6.84
	T. Aman, HYV	604.75	204.19	38.71	253.82	44.36	1.24	1860.00
	Monsoon crop Avg.(weighted)	609.9	126.14	33.34	128.19	28.24	0.88	101.22
	Boro, LV	590.33	202.71	35.11	322.04	24.30	0.49	886.24
	Boro, HYV	595.66	179.25	33.35	372.80	32.48	2.00	3422.38
	Average (Weighted)	603.47	148.21	33.25	225.14	29.65	1.28	1358.84
Impacted Unprotected	B. Aus LV	592.80	134.61	37.05	185.25	0.00	0.00	0.00
	T. Aus LV	-	-	-	-	-	-	-
	T. Aus HYV	655.19	126.47	37.31	366.40	82.08	2.20	447.74
	T. Aman LV	616.29	102.70	28.15	243.47	78.55	0.62	140.30
	Monsoon crop Avg.(weighted)	613.62	107.06	29.68	251.96	72.38	0.76	166.26
	Boro, LV	898.19	87.96	26.94	0.00	0.00	0.00	0.00
	Boro, HYV	621.92	128.76	31.89	396.76	54.04	2.68	2174.49
	Average (Weighted)	631.84	112.77	30.36	282.74	65.54	1.24	687.00
Control	B. Aus LV	711.21	122.02	36.53	124.49	56.86	0.00	62.74
	T. Aus LV	702.00	104.33	24.83	142.99	32.50	0.00	3939.00
	T. Aus HYV	602.98	213.41	34.30	305.07	38.43	1.22	1232.13
	B. Aus/Aman LV	718.55	165.04	33.53	74.84	0.00	0.39	0.00
	B. Aman LV	660.23	88.96	38.71	80.07	36.41	0.26	51.52
	T. Aman LV	678.21	151.83	34.05	146.62	39.25	0.34	0.00
	T. Aman, HYV	601.17	176.65	36.47	231.07	32.65	1.88	548.29
	Monsoon crop Avg.(weighted)	650.06	135.92	36.6	180.95	38.42	0.73	238.49
	Boro, LV	663.98	148.74	37.98	102.92	6.64	0.97	703.83
	Boro, HYV	646.55	174.65	34.97	315.62	32.53	2.34	5149.78
	Average (Weighted)	649.15	152.61	30.73	220.91	35.10	1.41	2371.79

Source: FAP - 12 PIE Household Survey

Table 4.13 **Per Hectare Use of Production Inputs: Non-Paddy Crops**
(per hectare)

Area characteristics	Non-Paddy crops	Seeds/ seedlings (Tk.)	Human labour (No.)	Animal labour (No.)	Fertilizer (kg.)	Manure (md.)	Pesticide (kg.)	Irrigation water (Tk.)
Impacted protected	Wheat	1291.78	155.02	41.19	191.42	56.71	0.45	371.68
	Jute	292.05	211.78	44.37	97.17	45.52	0.24	0.00
	Betel leaf	2705.66	1568.17	-			30.62	78.55
	Potato	7852.18	313.81	64.37	554.93	156.77	6.35	831.10
	Pulses	1006.67	91.73	14.94	15.56	20.75	0.00	0.00
	Oilseeds	246.16	84.97	23.48	44.56	35.64	0.00	
	Chilli	1498.62	363.50	51.08	147.88	32.11	1.50	238.13
	Onion/Garlic	1033.30	287.66	56.37	354.42	108.75	2.91	185.42
	Summer vegetables	1094.30	241.69	42.52	203.23	31.27	12.81	0.00
	Winter vegetables	957.00	625.06	60.99	816.61	88.20	11.80	3316.33
	Sweet potato	710.00	81.38	30.00	0.00	0.00	1.10	237.66
	Sugarcane	3293.32	232.80	50.67	395.20	0.00	4.11	0.00
	Others	1976.00	142.02	40.14	0.00	151.90	0.00	0.00
Impacted Unprotected	Potato	4771.60	126.86	69.61	1038.51	308.75	0.45	0.00
Control	Wheat	1394.22	138.62	38.02	194.71	61.35	0.35	1191.80
	Jute	567.68	215.16	45.76	146.40	68.07	0.38	0.00
	Betel leaf	2086.03	663.35	-			3.78	0.00
	Potato	5394.80	313.81	64.37	742.95	129.38	9.33	1725.07
	Pulses	1127.38	94.58	25.44	39.69	8.82	0.00	0.00
	Oilseeds	208.74	99.61	41.70	157.71	34.78	0.00	185.55
	Chilli	1644.53	259.45	40.68	262.36	25.76	1.67	988.00
	Onion/Garlic	2268.26	261.94	47.47	410.71	49.40	1.60	924.81
	Summer vegetables	1204.12	421.83	34.35	289.46	73.33	3.64	385.94
	Winter vegetables	2087.74	536.14	76.80	666.50	121.55	3.95	1097.77
	Sweet Potato	-	-	-	-	-	-	-
	Sugarcane	4610.67	465.60	29.39	0.00	0.00	0.00	0.00
	Others	1810.51	43.22	6.69	0.00	0.00	0.00	0.00

Source: FAP - 12 PIE Household Survey

4.8 COSTS, VALUE OF CROP OUTPUT AND NET RETURN

The total cost of production and the cost structure for different paddy and non-paddy crops are shown in Tables 4.14, 4.15, 4.16 and 4.17. The previous section has shown that there is hardly any difference in the technology of production between the protected and control areas for the paddy crops. The cost structure for the paddy crops in aggregate re-inforces the conclusion. For individual paddy crops again one finds little, if any difference in the total costs per ha. However, for all the paddy crops together the average weighted cost per acre in the control is just about 14 per cent higher.

A lower average yield (meaning lower gross return) and a higher cost per ha in the control area compared to the impacted have resulted in a higher net return per ha of paddy in the impacted area. The annual aggregate net output value of paddy crops, including by products is about 45 per cent more in the project area than in the control (Table 4.16). There would be no difference in the net return if "normal" yield is used for the calculation.

The per hectare net return for individual crops in the project area is much higher than that in the control area, the greatest difference being in the case of broadcast Aman. The per hectare return to B. Aman LV is about 14 times more in the project area than in the control which is actually a reflection of the yield difference. In all other cases, the difference in net return is the result of a somewhat higher gross return (and yield) and somewhat lower cost in the project area.

The per hectare return from non-paddy crops in the impacted area is in general more than that in the control area (Table 4.16). The overall return is about 18 per cent more in the impacted area compared to the control.

4.9 PROJECT TARGETS AND ACHIEVEMENTS

Although the project shows a slight increase in paddy output due to difference in crop yields, the major target of the project, reduction of flood damage, has not been achieved due to breaches and public cuts in the embankment. The Boro HYV has expanded in the protected area, but not more than that in the control area. The observed expansion of irrigation facilities in the project area is not an achievement of the project but is a result of introduction of DTWs and STWs as in other areas. Expansion of rabi crops other than Boro has not been achieved. Shifting from broadcast to transplanted variety during Aman season did occur in the project area but the expected benefit from shifting from local to high yielding varieties has not been achieved during that season.

The expected project benefits - such as a rise in cropping intensity to 235 per cent and increased production from 87299 mt to 135835 mt have not been achieved. In place of the expected 56 per cent increase the actual output growth has been only by 28 per cent (to 11965 mt).

Table 4.14 Total Input Cost and Cost Structure: Paddy Crops
(per hectare)

Area characteristics	Paddy	Seeds/ seedlings (%)	Human labour (%)	Animal labour (%)	Fertilizer manure (%)	Pesticide (%)	Irrigation (%)	Total (Tk.)
Impacted protected	B. Aus LV	14.35	36.83	32.00	15.27	1.55	0.00	4606.80
	T. Aus LV	9.65	38.46	26.94	15.42	7.41	2.13	7186.27
	T. Aus HYV	9.26	28.54	26.24	29.91	3.54	2.51	7542.89
	B. Aman LV	16.33	35.13	39.45	8.44	0.65	0.00	3703.96
	T. Aman LV	11.00	31.08	33.58	20.05	4.16	0.13	5330.60
	T. Aman, HYV	7.01	26.15	22.45	19.27	3.55	21.57	8621.87
	Boro, LV	7.12	37.85	21.16	21.70	1.46	10.69	8292.21
	Boro, HYV	4.48	37.59	12.55	15.87	3.73	25.76	13285.02
	Average (Weighted)	7.41	35.55	20.42	16.55	3.40	16.67	8174.00
Impacted Unprotected	B. Aus LV	11.74	31.78	36.67	19.80	0.00	0.00	5051.15
	T. Aus LV	-	-	-	-	-	-	-
	T. Aus HYV	10.18	10.39	28.98	35.04	8.46	6.95	6438.18
	B. Aman LV	-	-	-	-	-	-	-
	T. Aman LV	12.47	20.86	28.47	32.24	3.13	2.84	4943.66
	T. Aman, HYV	-	-	-	-	-	-	-
	Boro, LV	26.67	33.33	40.00	0.00	0.00	0.00	3368.19
	Boro, HYV	5.53	33.69	14.16	21.42	5.88	19.32	11255.83
	Average (Weighted)	10.91	24.32	25.61	27.87	4.04	7.26	6676.47
Control	B. Aus LV	14.17	30.16	36.39	18.03	0.00	1.25	5019.83
	T. Aus LV	8.71	14.11	15.40	12.90	0.00	48.87	8060.01
	T. Aus HYV	7.25	29.46	20.61	24.25	3.63	14.80	8322.53
	B. Aman LV	15.10	23.27	44.26	14.74	1.45	1.18	4373.06
	T. Aman LV	11.71	41.73	29.39	15.70	1.46	0.00	5793.67
	T. Aman, HYV	7.63	30.78	23.14	25.60	5.89	6.96	7881.40
	Boro, LV	8.98	44.11	25.69	8.46	3.23	9.52	7392.08
	Boro, HYV	4.60	28.49	12.45	13.66	4.11	36.68	14040.34
	Average (Weighted)	7.18	30.13	15.92	16.48	3.88	26.41	9316.00

Source: FAP - 12 PIE Household Survey

Note: The cost of animal labour includes cost of associated human labour and thus over-states the percentage contribution of animal labour and understates that of human labour.

Table 4.15 **Total Input Cost and Cost Structure : Non-Paddy Crops**
(per hectare)

Area characteristics	Non-Paddy crops	Seeds/ seedlings (%)	Human labour (%)	Animal labour (%)	Fertilizer manure (%)	Pesticide (%)	Irrigation (%)	Other cost (Tk.)	Total (Tk.)
Impacted protected	Wheat	17.48	29.98	27.86	18.16	1.50	5.03		7391.82
	Jute	5.45	38.03	41.37	14.70	0.45	0.00		5361.82
	Betel leaf	1.38	32.13	0.00	12.38	1.57	0.04	52.49	195237.21
	Potato	38.81	22.66	15.50	16.97	3.06	4.00		20769.13
	Pulses	26.47	46.39	19.65	7.50	0.00	0.00		3802.93
	Oilseeds	6.57	44.88	31.35	10.86	0.00	6.35		3744.88
	Chilli	13.77	50.78	23.48	8.40	1.38	2.19		10879.04
	Onion/Garlic	9.97	34.17	27.18	24.08	2.81	1.79		10367.65
	Summer vegetables	10.69	41.70	20.78	14.30	12.53	0.00		10233.33
	Winter vegetables	4.21	41.22	13.40	21.72	4.87	14.58		22747.89
	Sweet potato	12.18	53.53	24.67	7.81	1.81	0.00		6081.22
	Sugarcane	17.82	50.38	17.82	11.76	2.23	0.00	-	18483.81
	Others	25.81	27.82	26.21	20.16	0.00	0.00		7656.92
Impacted Unprotected	Potato	26.32	10.50	19.20	43.36	0.62	0.00	0.00	18126.30
Control	Wheat	17.80	23.16	24.27	17.96	1.12	15.22		7831.51
	Jute	8.58	37.83	34.58	17.61	1.40	0.00		6617.76
	Betel leaf	1.20	15.26	-	14.73	2.60	0.00	66.21	173876.19
	Potato	24.56	22.84	19.01	21.49	4.25	7.85		21967.33
	Pulses	24.31	41.46	27.42	6.81	0.00	0.00	0.00	4638.31
	Oilseeds	4.74	21.13	47.36	22.55	0.00	4.22		4402.07
	Chilli	13.94	45.25	17.24	13.78	1.42	8.37		11800.59
	Onion/Garlic	20.65	22.49	21.61	23.21	3.61	8.42		10982.19
	Summer vegetables	9.60	50.41	13.68	16.08	7.16	3.07		12552.61
	Winter vegetables	9.42	43.15	17.32	20.76	4.40	4.95		22167.26
	Sugarcane	15.91	64.26	6.59	11.82	1.42	0.00		28981.33
	Others	24.83	25.41	28.31	21.43	0.00	0.00		7288.96

Source: FAP - 12 PIE Household Survey

Note : See Table 4.14

Table 4.16 Per Hectare Cost of Production, Yield and Return by Crops

Crops/Cost Return	Impacted Area		Control Area
	Protected	Unprotected	
1. B. Aus, LV			
A. Grain Yield (tons)	1.94	2.26	1.72
By Product (tons)	3.88	4.52	3.44
B. Total Cost of Production (Tk.)	4606.80	5051.15	5019.83
C. Gross Return (Tk.)	14430.07	16810.29	12793.67
D. Net Return (Tk.)	9823.27	11759.14	7773.84
2. T. Aus, LV			
A. Grain Yield (tons)	2.74		2.30
By Product (tons)	4.46		4.60
B. Total Cost of Production (Tk.)	7186.27		8060.01
C. Gross Return (Tk.)	20053.89		17724.01
D. Net Return (Tk.)	12867.62		9664.00
3. T. Aus, HYV			
A. Grain Yield (tons)	8.47	3.18	3.05
By Product (tons)	3.47	3.18	3.05
B. Total Cost of Production (Tk.)	7542.89	6438.18	8322.53
C. Gross Return (Tk.)	23158.78	21223.32	20355.70
D. Net Return (Tk.)	15615.89	14785.14	12033.17
4. Aus/Aman, Mixed			
A. Grain Yield (tons)			1.68
By Product (tons)			3.36
B. Total Cost of Production (Tk.)			4812.76
C. Gross Return (Tk.)			1161.34
D. Net Return (Tk.)			6797.58
5. B. Aman, LV			
A. Grain Yield (tons)	1.60		0.92
By Product (tons)	1.60		0.92
B. Total Cost of Production (Tk.)	3703.96		4373.06
C. Gross Return (Tk.)	8106.46		4661.22
D. Net Return (Tk.)	4402.50		288.16
6. T. Aman, LV			
A. Grain Yield (tons)	2.23	2.22	2.04
By Product (tons)	4.46	4.44	4.08
B. Total Cost of Production (Tk.)	5330.60	4943.66	5793.67
C. Gross Return (Tk.)	15989.70	15918.00	14627.35
D. Net Return (Tk.)	10659.10	10974.34	8833.68
7. T. Aman, HYV			
A. Grain Yield (tons)	3.80		3.11
By Product (tons)	3.80		3.11
B. Total Cost of Production (Tk.)	8621.87		7881.40
C. Gross Return (Tk.)	25361.20		20756.14
D. Net Return (Tk.)	16739.33		12874.74
8. Boro, LV			
A. Grain Yield (tons)	1.83	2.02	2.48
By Product (tons)	3.66	4.04	4.96
B. Total Cost of Production (Tk.)	8292.21	3368.19	7392.08
C. Gross Return (Tk.)	13611.87	15025.12	18446.68
D. Net Return (Tk.)	5319.66	11656.93	11055.61
9. Boro, HYV			
A. Grain Yield (tons)	4.47	4.26	3.69
By Product (tons)	4.47	4.26	3.69
B. Total Cost of Production (Tk.)	13285.02	11255.83	14040.34
C. Gross Return (Tk.)	25641.35	24436.72	21167.02
D. Net Return (Tk.)	12356.33	13180.89	7126.68
Weighted Average all paddy (Return)	**10166.18**	**11949.42**	**7011.20**
10. Wheat			
A. Grain Yield (tons)	1.98		1.84
By Product (tons)			
B. Total Cost of Production (Tk.)	7391.82		7831.51
C. Gross Return (Tk.)	7956.90		7394.30
D. Net Return (Tk.)	565.09		-437.21
11. Jute			
A. Grain Yield (tons)	1.29	-	0.93
By Product (tons)			
B. Total Cost of Production (Tk.)	5361.82	-	6617.76
C. Gross Return (Tk.)	10368.08	-	7474.66
D. Net Return (Tk.)	5006.26	-	856.90

Table 4.16 Per Hectare Cost of Production, Yield and Return by Crops (continued)

Crops/Cost Return	Impacted Area		Control Area
	Protected	Unprotected	
12. Potato			
A. Grain Yield (tons)	10.09	11.18	11.62
By Product (tons)			
B. Total Cost of Production (Tk.)	20769.13	18126.30	21967.33
C. Gross Return (Tk.)	19246.17	17971.29	18678.60
D. Net Return (Tk.)	-1522.96	-155.01	-3288.76
13. Pulses			
A. Grain Yield (tons)	1.07		0.93
By Product (tons)			
B. Total Cost of Production (Tk.)	3802.93		4638.31
C. Gross Return (Tk.)	17199.76		14949.32
D. Net Return (Tk.)	13396.83		10311.01
14. Chilli			
A. Grain Yield (tons)	3.08		3.61
By Product (tons)			
B. Total Cost of Production (Tk.)	10879.04		11800.59
C. Gross Return (Tk.)	43120.00		50540.00
D. Net Return (Tk.)	32240.96		38739.41
15. Oil Seeds			
A. Grain Yield (tons)	1.19		0.83
By Product (tons)			
B. Total Cost of Production (Tk.)	3744.88		4402.07
C. Gross Return (Tk.)	12752.47		8894.58
D. Net Return (Tk.)	9007.59		4492.51
16. Winter Vegetables			
A. Grain Yield (tons)	23.04		12.84
By Product (tons)			
B. Total Cost of Production (Tk.)	22747.89		22167.26
C. Gross Return (Tk.)	135797.76		75678.96
D. Net Return (Tk.)	113049.87		53511.70
17. Summer Vegetables			
A. Grain Yield (tons)	3.07		7.68
By Product (tons)			
B. Total Cost of Production (Tk.)	10233.33		12552.61
C. Gross Return (Tk.)	20562.03		51438.57
D. Net Return (Tk.)	10328.70		38885.96
18. Sweet Potato			
A. Grain Yield (tons)	0.65		
By Product (tons)			
B. Total Cost of Production (Tk.)	6081.22		
C. Gross Return (Tk.)	1393.08		
D. Net Return (Tk.)	-4688.14		
19. Onion/Garlic			
A. Grain Yield (tons)	6.60		8.13
By Product (tons)			
B. Total Cost of Production (Tk.)	10367.65		10982.19
C. Gross Return (Tk.)	88409.97		108905.01
D. Net Return (Tk.)	78042.32		97922.82
20. Sugarcane			
A. Grain Yield (tons)	30.73		1.84
By Product (tons)			
B. Total Cost of Production (Tk.)	22747.89		28981.33
C. Gross Return (Tk.)	31284.68		1873.21
D. Net Return (Tk.)	8536.79		-27108.12
21. Betel Leaf			
A. Grain Yield (poas[1]/ha)	475.28		571.06
By Product			
B. Total Cost of Production (Tk.)	195237.00		173876.19
C. Gross Return (Tk.)	608358.40		730956.80
D. Net Return (Tk.)	413121.40		557080.61
22. Others			
A. Grain Yield (tons)	1.08		4.77
By Product (tons)			
B. Total Cost of Production (Tk.)	7656.92		7288.96
C. Gross Return (Tk.)	7667.56		33865.04
D. Net Return (Tk.)	10.64		266576.08

Source: FAP - 12 PIE Household Survey

Note: [1]Poa = 2048 leaves

A question remains whether all of this increase is due to the project. If earlier discussions on the project impact on irrigation is correct, then one should look at the changes in monsoon paddy output. Then again one would have to net out the autonomous changes over time for which we use the control area parameters as the surrogate. On that basis it has been estimated as shown in Table 4.17 that at most 6895 mt or just about 6 per cent of the study year output can be said to be the direct output impact of the Project. This is however, about 17 per cent more than the monsoon period paddy output in the control area.

The study year, it has been observed before, has been rather a bad year in the control area. As an alternative measure of output impact, the 'normal' yield as stated by farmers have been used in estimation of output impact. The Project is, in such a situation, found to have little, in fact a negative, impact on output. The paddy output in the protected area during the monsoon is observed to be 2.6 per cent less than that in the control.

Table 4.17 Estimated Paddy Output in CBPD Area

Indicators	Protected (actual)	Protected (notional)	Difference
Net cultivable area (ha)	37235	37235	-
Paddy Cropping intensity (%) -			
All	100.87	99.54	-
Monsoon	60.13	55.87	-
Gross Cultivated Paddy Area (ha) -			
All	37572	37075	497
Monsoon	22389	20805	1584
Paddy Yield (mt/ha) -			
All	2.98	2.68	0.30
Monsoon (study year)	2.12	1.95	0.17
Monsoon (normal)	2.37	2.62	-0.25
Paddy Output (mt) -			
All	111965	99361	12604 (12.7)
Monsoon (study year)	47465	40570	6895 (17.9)
Monsoon (normal)	53062	54509	-1447 (-2.6)

Source : Estimated on the basis of information and data from FAP 12 PIE Household Survey, 1991.

Note: 1. Protected (actual) is defined as estimates based on actual observations in the protected area. Protected (notional) refers to notional changes in the protected area if it has not been protected i.e., the parameters used here for the estimates are those observed in the control area.

2. Figures in parentheses indicate percentage difference of Protected (actual) over Protected (notional).

5 LIVESTOCK

5.1 INTRODUCTION

Agriculture is the main occupation of the people in the Project area and around 70 per cent of the total households are farm households. Livestock is an integral part of the farming system in the area. Animals are kept primarily as a supporting activity to crop production and secondarily as sources of animal protein in the form of milk, meat and eggs, and of cash income to the farm households. Each farm household keeps a small number of livestock as scavenging animals.

Important animals in the project area are cattle, goats, chicken and ducks. A few buffaloes and sheep are kept by some households but horses are very rare. According to Bangladesh Census of Agriculture and Livestock, 1983-84, about 51 per cent of the total households have bovine, 48 per cent have goats and sheep, and 68 per cent have chicken and ducks in the Rajshahi District.

Economically cattle are the most important livestock in the project area. Bullocks are kept mainly for draught power and cows for milk and calves. However, during the peak ploughing season cows are also used as draught animals by all types of farm households to overcome draught power shortages.

The project studied generally had no explicit objectives related to livestock development. But it was expected that the project would have an impact on crop production through changing the cultivable area, cropping pattern and cropping intensity. The increased cropped area and cropping intensity would lead to reduction of fallow land and grazing area for livestock on one hand and increased requirements for draught animals on the other hand. It is anticipated that any change in the availability of feeds would lead to changes in the production cost and livestock output. In general the planners, at the time of project planning, rarely have considered the project impacts on the inputs and outputs of livestock particularly draught power requirement, and how to meet the increased demand of draught power for timely land preparation. In case of CBPD, however, there was a clear warning in the Feasibility Report on the adverse impact the Project may have on an already precarious livestock situation in the project area.

Although the Project would not have direct impacts on livestock production parameters, one may expect that it would have effect on livestock feed resources and disease occurrence, which will, in turn, influence the livestock production in the area. The expected impacts of the Project on livestock may be observed in one or more of the following areas:

- Size of livestock holdings and numbers of owning households;
- Livestock feed resources;
- Draught power availability and demand;
- Livestock outputs;

- Livestock health and incidence of diseases.

- Prevention of damage to livestock during floods.

In the following pages an attempt will be made to analyze the available PIE Household Survey data as well as the RRA findings in order to assess the impacts of the Project on livestock production.

5.2 DISTRIBUTION OF SAMPLE HOUSEHOLDS

In total 252 households were interviewed and the data on livestock production were collected in the pre-tested questionnaire. Out of 252 sample households 154 were in the protected area, 14 in the unprotected area and 84 in the control area. Details of the households are shown in Table 5.1

Table 5.1 Distribution of the Sample Households by Land Holding Category and Protection Status.

Land holding category	Impacted Area		Control	All
	Protected	Unprotected		
Landless Households	44	4	24	72
Marginal+Small Farm HH	82	4	51	137
Medium+Large Farm HH	28	6	9	43
All households	154	14	84	252

Source: FAP-12 PIE Household Survey.
Note: Bovine HH = Household owning Bovine animals.
The landless households are thus drawn from among the labour households.

Because of the very small number of sample households in the unprotected area, these have been amalgamated with the sample from the protected area for much of the subsequent analyses.

5.3 IMPACTS ON LIVESTOCK HOLDING

5.3.1 Ownership of Livestock

One-half or slightly more of the sample households has been found to own bovines in the Project area. There is little or no variation in the aggregate proportion between the impacted and control area (Table 5.2). Cattle is the most important species of bovine and buffaloes are rarely kept in the project area except by a few medium and large farm households.

The available data provide a clear indication that the number of bovine owning households increases with increasing farm size in both the impacted and control areas

(Table 5.2). The increased number of bovine holding households with increasing farm size may be due to their higher demand for draught animals for land preparation. Moreover, medium and large farm households have more financial ability and feed resources for procuring and maintaining livestock, particularly bovines. There is no significant difference in the percentage of bovine owning households between the protected and control areas for any of the land holding categories.

Table 5.2 Selected Indicators of Livestock Ownership by Landholding

Landholding Category	Owner households		Average No. per HH		Av. No. per Owning HH	
	Impacted	Control	Impacted	Control	Impacted	Control
Bovine						
Landless	8 (17)	4 (17)	0.3	0.3	1.6	1.5
Marginal and Small	48 (56)	29 (57)	1.5	1.2	2.8	2.2
Medium and Large	33 (97)	9 (100)	4.3	3.3	4.4	3.3
All	89 (53)	42 (50)	1.7	1.2	3.3	2.4
Ovine						
Landless	13 (27)	7 (29)	0.8	0.6	2.9	2.1
Marginal and Small	35 (41)	26 (51)	1.2	1.7	2.8	3.3
Medium and Large	19 (56)	5 (58)	1.7	2.1	3.3	3.8
All	67 (40)	38 (45)	1.1	1.4	3.1	3.2
Poultry						
Landless	22 (46)	13 (54)	2.9	3.6	6.5	6.7
Marginal and Small	73 (85)	45 (88)	10.3	8.5	12.2	9.6
Medium and Large	32 (94)	9 (100)	22.9	18.2	24.3	18.2
All	127 (76)	67 (80)	10.8	8.1	14.2	10.2

Source: FAP 12 PIE Household Survey.

Note : Figures in parentheses indicate percentage of households owning the particular type of livestock in the relevant landholding category.

The PIE results indicate that goats and sheep are also important species of livestock in the project area. Around 40-45 per cent of the total households possessed ovines, particularly goats in small numbers as scavenging animals (Table 5.2). The results show a clear pattern that the number of ovine owning households increases with increasing farm size (Table 5.2). There is apparently no significant difference in the percentage of ovine owning households between the impacted and control areas. RRA findings indicate an increase in sheep and goat populations between pre-project and post-project conditions. This confirms the findings of the Bangladesh Census of Agriculture and Livestock, 1983-84, that the goat population has increased somewhat over recent years.

Regarding poultry, the PIE results show that about 75-80 per cent of total households possess poultry birds, and chickens are the predominant species of poultry in the project area. About 70-75 per cent of the total households have chickens and 43-50 per cent of the households have ducks. The Household Survey results clearly show that the number of poultry owning households increases with increasing land holding (Table 5.2). The PIE results also indicate that the number of poultry owning households is smaller in the protected area than in the control area. However, the differences between the protected and the control areas are very small. The small differences in livestock owning households between the protected and control areas suggest that the project has little impact on the number of livestock owning households.

5.3.2 Size of Livestock Holding

Table 5.2 shows the average number of livestock of different categories by land holding size both on an average and among owner households. Several conclusions may be drawn from the table. These are as follows:

- whether estimated on a per household or per owner household basis, there appears to be a systematic, however small, difference between the impacted and control areas. In case of bovines and poultry the size of the holding is higher in the impacted area and in case of ovine the relationship is just the opposite;

- when the average bovine holding size is matched against average operated holdings, the relationship is reversed. Control areas farmer are found to have 1.18 heads per acre while in the impacted area it is found to be just about one head per acre;

- in every case, the average size increases with land holding. The rate of increase with land holding is particularly sharp in case of poultry and also in case of bovine but is rather slow in case of goats and sheep;

- the reason for rise in the case of bovines is quite easily explained in terms of the need for draught power and increase in affordability to keep female cows for milk.

5.4 IMPACTS ON DRAUGHT POWER

5.4.1 Draught Power Requirement

The PIE data indicate that the operated land per household was higher in the impacted area than in the control (Table 5.3). The cropped area per household was highest in the Boro season followed by the Aman season in both the impacted and control areas. The actual cropped area per household in all seasons was higher in the protected area than the control area. The difference was the most noticeable during the Aman season.

Table 5.3 Operated and Cropped Areas per Household in Different Cropping Season (in acre)

Indicator	Impacted Area	Control Area
Total operated area	1.67	1.02
Cropped Area in:		
- Aus Season	0.31	0.28
- Aman Season	0.87	0.48
- Boro Season	0.87	0.71
- All season	2.05	1.47

Source: FAP 12 PIE Household Survey

5.4.2 Draught Animal Availability

The most important contribution of bovine animals is the supply of draught power to the farm household for land preparation. As already shown in the earlier sections, the percentages of bovine owning households and the size of bovine holdings vary with the farm size and between the impacted and control areas. Bullocks and bulls are the most important animals for draught power. However, cows are also used for draught power when there is any shortage. Small and marginal farm households in particular are increasingly using cows for draught purposes.

Table 5.4 shows the average size of bovine holding per household and its composition both in the protected and control areas. The number of bovines per household was higher in the impacted area than the control. There was a higher number of bullocks, cows and calves per household in the impacted area. But the proportions of bullocks, and bulls, cows and calves in the total numbers of bovines in the protected and control areas are almost the same. Bullocks and bulls constitute about 50 percent of the total bovine animals (Table 5.4).

Since the draught power capacity of different types of bovine is not the same, all bovine animals are converted into Draught Animal Units (DAU) by using the following conversion factor.

DAU = 1 x (Bullocks + Bulls) + 0.5 x Cows + 2 x Buffaloes

the estimated availability of DAU per household in the impacted and control areas is shown in Table 5.4. It can be seen from the table that about 78 percent of the total DAU comes from bullocks and bulls and practically the rest from cows in both the impacted and control areas. Availability of DAU per household was much higher in the impacted area than in the control. The number of DAU per acre of operated land was, however, slightly lower in the impacted area.

Table 5.4 Composition of Bovine Holding in the Protected and Control Area.

Type of Animal/HH	Impacted Area	Control Area
Bullock + Bull/HH	0.82	0.57
Cows/HH	0.47	0.32
Calves/HH	0.43	0.24
Buffaloes/HH	0.01	0
Total Bovine/HH	1.73	1.18
DAU/HH	1.07	0.73
DAU/Acre operated land	0.64	0.72

Source: FAP 12 PIE Household Survey
Note: HH = Household

5.4.3 Demand and supply of Draught Power

The demand for draught power depends on several factors, viz; the cropped area in a season, the time available for ploughing, the tillage requirement for the crop being cultivated, the hardness of the soil and the like. In all cases except the second one these demand will be higher the greater is the value of the variable in question. Farmers in general adjust to the hardness problem by ploughing their fields after a shower or two except in the Boro season when irrigation water is used to soften the soil. The question of number of tillage is difficult to address but as much of the land is under paddy of one variety or the other, the tillage requirements in the present situation can be taken to remain constant over season and between areas. The time available for tillage given the area of land to be ploughed is very crucial as the demand may be expressed over a short period or a long one. The shorter the period, the more critical is the problem.

In general a pair of DAU can cultivate at best 2 acres of land in 30 days. In the Boro season, when irrigation water is used, the time available for land preparation is quite long, around 45-60 days. But in the Aus and Aman seasons, when land preparation and sowing/planting are dependent on natural rainfall, the time available for land preparation and sowing/planting is very short - usually 25-30 days. As such, when a greater area of land has to be cultivated in a short period of time, the supply of draught power for land preparation may be inadequate for medium and large farm households.

Average operated land areas per pair of DAU in important crop seasons and for medium + large farm households are shown in Table 5.5. The results indicate that there was a higher acreage of operated land per pair of DAU for the medium + large farm household than for the average household both in the protected and control areas. In the Aman season the acreage per pair of DAU was higher in the protected area than in the control area. But in the Boro season, there is a greater acreage of land per pair of DAU in the control area than in the protected area. However, the acreage per pair of DAU is less than two acres in all seasons and for different categories of farm households.

Table 5.5 Draught Power Requirement and Supply in Critical Seasons and with M+L Household

Land/Pair DAU (in acre)	Impacted Area		Control Area
	Protected Area	Unprotected Area	
DAU/HH (in No)	1.09	0.97	0.73
Operated land/ Pair DAU	2.95	4.89	2.79
Operated land pair DAU for M+L Farm HH	3.51	4.64	3.13
Cropped Land/Pair DAU in Aman Season	1.48	3.15	1.32
Cropped Land/Pair DAU in Aman season for M+L Farm HH	1.73	2.97	1.38
Cropped Land/Pair DAU in Boro Season	1.60	1.72	1.92
Cropped Land/Pair DAU in Boro Season for M+L Farm HH	1.67	1.49	2.12

Note: M+L = Medium and large, HH = Household
Source: FAP 12 PIE Household Survey

The time requirements for cultivation of operated land by the different categories of farm household in different seasons are shown in Table 5.6. It can be seen from the table that the time requirement for cultivation of operated land with the available DAU both in the protected and control areas is less than 30 days. This is the case in different cropping seasons and for different categories of farm household.

Table 5.6 Time Requirement for Cultivation of Land per Household in Different Cropping Seasons (in days)

Farm Household	Time required for cultivation of land/HH in different season								
	Protected Area			Unprotected Area			Control Area		
	Aus	Aman	Boro	Aus	Aman	Boro	Aus	Aman	Boro
Marginal + Small	9	19	24	60	160	139	12	20	29
Medium + Large	8	26	25	10	45	22	13	21	32
All Type	8	22	24	12	47	26	12	20	29

Source: FAP 12 PIE Household Survey.

The above results indicate that there is apparently no shortage of draught animals in the area. The Project has had little impact in changing draught animal requirements in the area. The draught animal requirement for land preparation in the Boro and Aman seasons is almost the same. But note that in the unprotected area where the main crop is T Aman, LV, all farmers face a severe time constraint. In most other cases they are operating roughly at the margin of shortage. Indeed if the farmers want to cultivate all their operated land in a given season, in no place would they be able to do so, as the time for tillage (44, 73 and 42 days in protected, unprotected and control areas respectively) will be so long and the growth period would be so short that the over-all yield may turn out to be uneconomic. This may be one of the reasons why the cropped area is much lower than the operated area in all three seasons.

5.5 IMPACTS ON LIVESTOCK FEEDS

It may be anticipated that due to the Project there would be some impact on livestock feed resources, particularly on fallow land and grazing area, and thereby on availability of green feedstuff. It may further be anticipated that with the increased production of paddy there would be a concomitant increase in paddy straw and rice bran for bovine animals. The RRA results indicated that the grazing area had been reduced due to conversion of fallow land into crop fields. The PIE results suggest that this is due to autonomous increases in Boro HYV irrigation, and is not a project impact.

The RRA results provided further indication that the straw production, on the contrary, had increased in the Project area, particularly due to increased Boro and Aman production. But the palatability and digestibility of the straw have declined due to production of HYVs rather local varieties. It is assumed that with the increased production of paddy there would be an increased production of rice bran in the Project area.

In order to find out the status of livestock feeds in the Project area, the Household Survey data on livestock feeds and feeding were analyzed and the results are presented in Table 5.7. It can be seen from the table that only around 25 per cent of the total households provide green grasses to their bovine animals. However, there is no significant difference in feeding practices of bovine animals between the protected and control areas. This is not surprising given that no more than 6 per cent of the total paddy production in the Protected area can be attributed directly to the Project.

The amount spent per owner household for feeding their bovine animals is also shown in Table 5.7. It can be seen from the Table that on the average there are no big differences in household expenditure for feeding bovine animals between the protected and control areas either in the aggregate or in its composition. This gives an indication that the declining availability of green feeds in the Project area may not be mainly due to the Project.

One notices that although there is no difference in the expenditure per household, there appears to be a much lower expenditure per bovine animal in the protected area compared to expenditures in other areas. What this could means is that in the protected area, fallow land can possibly be used for grazing but in the other areas, inundation may have precluded any such use. Thus the questions of availability of grazing land, cropping intensities and inundation need to be studied together to understand the dynamics of the problem.

5.6 IMPACTS ON LIVESTOCK HEALTH

It may be expected that the Project might have some impact on livestock health and incidence of diseases. During the pre-project condition there were regular floods which washed away all debris and other polluted materials and thereby may have reduced the incidence of diseases. But after the Project, stagnation and low water depth in the waterbodies may facilitate growth of some types of parasites.

Table 5.7 Feeding Practices and Expenditure on Feed for Bovine Animals Over the Study Year (1990-91).

Area	Percentage HH feeding			Expenditure per owner HH (Tk.)			Total	Expenditure per bovine
	Green feed	Dry feed	Concentrates	Green feed	Dry feed	Concentrates		
Protected	24	49	45	403	1152	684	2239	700
Unprotected	14	57	64	350	2525	761	3636	909
Control	23	51	48	620	1210	526	2356	982

Source: FAP-12 PIE Household Survey

There appears to be little difference in the proportion of households who have used veterinary services (about 30 per cent) but the amounts spent are much higher in the control areas (Tk. 158) compared to the protected (Tk. 87). Obviously, it is not possible to conclude on the basis of this information if the project had any impact on such expenditure.

The RRA results suggested that there has been a general deterioration over time in cattle health mainly due to shortages of nutritious feed, extreme seasonal fluctuations of feed supply and seasonal over work of the animals. These impacts may have been equally felt in the control area.

5.7 HOUSEHOLD INCOME FROM LIVESTOCK

The average gross income from livestock, estimated cost of upkeep of animals and the resulting net return are shown in Table 5.8. There appears to be little difference in any of these values between the impacted and control areas. But the pattern of accrual of gross income is somewhat different. In the impacted area nearly 62 per cent of the gross income is due to sales of live animals. Nearly 60 per cent of this is due to sales of bovine animals. In contrast, the respective percentages in the control area are approximately 80 and 70 per cent. The difference may well be due to distress sales in the control area during times of flood, particularly as the study year was a bad year in the control area.

Table 5.8 Livestock Income By Source in the CBPD Areas
(Tk./household)

Source	Impacted	Control
Sale of live animal (% bovine)	1407 (59)	1693 (69)
Milk	406	92
Meat	78	10
Eggs	154	140
Others	207	152
Gross income	2252	2087
Cost of upkeep	1097	1031
Net Income	1155	1056

Source: FAP-12 PIE Household Survey.
Note: The value of tillage services of bovine is not included in gross income.

5.8 SUMMARY AND CONCLUDING REMARKS

On the whole there appears to be little or no difference between the impacted and control areas in terms of the various indicators of status of livestock holding, use and production. Indeed the general impression gained during the RRA in CBPD is that the livestock problems due to reduction in grazing area may only reflect a general trend and may have little to do with the project. It may also be argued that in fact the reduction in the area and duration of inundation have allowed seasonal grazing land to be available for foraging while in the control area this may not be possible due to inundation. Such arguments are also consistent with the RRA finding that the cattle population in the impacted area has increased since Project completion.

What remains a major concern in both the areas is that the availability of draught power may have acted as a constraint, in addition to all others, in the fuller utilisation of land. Flood protection alone may therefore be not enough for increasing cropped area in any given season.

As the Project may have had little to do with the livestock situation and as there is a general shortage of livestock, the measures that may be taken for livestock improvement should rather be of general nature. These relate to development and selection of HYV paddy for straw quality; popularisation of urea treatment of straw and introduction of urea-molasses blocks. For a fruitful and effective measure the Department of Livestock Services should be extended and strengthened.

6 FISHERIES

6.1 CAPTURE FISHERIES

6.1.1 Catch and Effort

Seventeen fishermen were interviewed in the project/impacted area and 15 in the control. There are no reliable data on total number of "professional" fishermen, but as the area supported a substantial fishery in the past the number could have been very large. It is now estimated that there are at least 2500 in Polder D and 500 in the control area, although greater figures, up to 4000, have been quoted.

The average daily catch and the average number of fishing days per year per fisherman were assessed from PIE responses and are shown in Table 6.1 and Table 6.2.

Table 6.1 Average Capture Fish Catch per Fisherman per Day (Kg.)

	Impacted Area	Control Area
Now	3.8	3.6
Before	5.1	4.3

Source: FAP 12 PIE Household Survey

Table 6.2 Average Number of Fishing Days per Fisherman per Year.

	Peak Period	Lean Period	Total
Impacted Area			
Now	97	49	146
Before	115	62	177
Control Area			
Now	119	63	182
Before	124	68	192

Source: FAP 12 PIE Household Survey

There has, clearly, been a substantial decline, in both areas, in average daily catch and numbers of fishing days, from which it is possible to deduce that annual catches in the impacted area have declined by at least 40 per cent, whereas in the control area the fall is only about 20 per cent. This is not as great a fall as was suggested during the RRA study, when reports spoke of up to a 75 per cent drop in fish production. The small size of the PIE sample indicates that more detailed study of landing volumes and changes in catch rates is required, along with more accurate assessment of the numbers, distribution and changes in the fishing work force, in each project area and generally, for each Upazila.

Peak and lean fishing periods were recorded for the river, beel, channel and pond fisheries in the impacted and control areas. It is clear that these periods are governed by the timing and duration of the annual flood and will therefore vary slightly from one year to another. Minor differences in timing, as recorded between control and impacted areas are not regarded as significant. In general the peak season extends from August-September until February, namely the last part of the monsoon flood and the post-monsoon period, and the lean season follows on from February until August.

Fishermen's responses regarding their catches, by average quantity and value, and by main fish species groups, are set out in Table 6.3. These figures indicate that the overall catch is much lower in the impacted area but nearly 70 per cent of the difference is due to the difference in catch in pond fisheries although capture fisheries are also somewhat lower in the impacted area.

There is another implication of these figures. The total estimated annual catch indicates the present levels of catch per fishermen per day to be 5.5 kg. and 6.7 kg. in the impacted and control areas. These are certainly at odds with the figures in Table 6.1 and point to the need for more focused investigations.

Table 6.3 Average Catch per Fisherman During 1990/91
(Quantities in Kg. Values in Tk.)

Species	Impacted		Control	
	Quantity	Value	Quantity	Value
Major Carps	91	2830	150	4879
Catfish	145	3521	96	3389
Snake-heads	53	765	88	2444
Minor Carps	13	352	13	370
Live Fish	40	1684	46	2184
Shrimp	100	1148	70	583
Other Species	108	1274	199	8382
Total Capture Fish	550	11574	662	22231
Pond fish (mainly Carp)	260	7076	562	17638
Overall Totals	810	18650	1224	39869

Source: FAP 12 PIE Household Survey

It was not considered feasible to attempt recording fishermen's recollections of catches and values prior to the project in such great detail. Instead, they were asked to compare the 1990/91 and pre-project catches in more general terms, as shown in Table 6.4.

Table 6.4 Comparison of 1990/91 and Pre-project catches
(Nos. of fishermen)

Extent of Change	Impacted	Control
Increased more than 25%	-	3
Increased upto 25%	1	6
Catch about the same	2	1
Decreased upto 25%	2	3
Decreased more than 25%	12	2
Total Nos. of respondents	17	15

Source: FAP 12 PIE Household Survey

This result is consistent with the earlier findings about falling capture fisheries production. However, as will also be seen later, the Chalan Beel area also supports large numbers of fish ponds, the owners of which frequently use fishermen to harvest their marketable fish. It appears that this is even more important as a source of catch and income for fishermen in the control area. This probably also explains the seeming anomaly of an increase in major carps in the catches of some fishermen whereas they were decreasing, along with all other species, according to the majority of fishermen, and as shown in Table 6.5.

Table 6.5 Changes in Species Composition in the Catch
(No. of Fishermen Responding)

Species		Increase		No Change	Decrease	
		25% plus	Up to 25%		Up to 25%	25% plus
Major Carps	Impacted	5	2	-	1	9
	Control	3	5	1	1	7
Catfish	Impacted	1	2	-	1	10
	Control	-	-	-	6	6
Live Fish	Impacted	-	-	-	2	9
	Control	-	-	-	3	2
Minor Carps	Impacted	-	-	-	-	3
	Control	-	-	-	-	3
Snake-heads	Impacted	-	-	-	-	4
	Control	-	-	-	7	4
Shrimp	Impacted	1	1	-	1	7
	Control	-	1	-	-	2
Other Species	Impacted	1	-	-	1	3
	Control	-	-	-	3	5

Source: FAP 12 PIE Household Survey

Amongst a number of mainly non-project related causes of the declines in fish stocks and catches, fishermen from the project and control areas cited the reasons, listed in

Table 6.6. The table clearly shows that the construction of the embankment did have a clear negative impact. Note that, a similar reason has also been cited by fishermen in the control area. These may be two reasons for this. Either fishermen from the control area also fish in the Project area, a distinct possibility given that these are, contiguous areas, or that the embankment under construction in the control area has already begun to have adverse impacts on the water bodies there-in or both.

Table 6.6 Fishermen's views on Causes of Project Impact
(Number of Fishermen responding)

Cause of Impact	Impacted Area	Control Area
Fish access blocked by embankments	16	3
Drying of water bodies	5	4
Decrease in fishing area	2	2
Difficulty of water transport	1	-
Increased use of fertiliser and pesticide	1	-

Source: FAP 12 PIE Household Survey

6.1.2 Costs and Returns

Fishermen's income and expenditure was assessed from their responses as detailed in Table 6.7. Several conclusions may be drawn from the table. In the first place, gross income/including home consumption) in the impacted area is 53 per cent less than in the control. Of the difference in cross value 45 per cent can be attributed to catch difference while the rest, 55 per cent, is due to price difference a major reason for which must have been the much lower importance of major carps in the impacted area.

One also finds a cost-difference. The cost per unit of catch is Tk. 8.6/kg. in the control area which is much higher than that in the impacted area (Tk. 3.4/kg.). Despite this the net return in the control area still remains far above (by 84 per cent) that in the impacted area.

Table 6.7 Fishermen's Income and Expenditure, 1990/91 (Tk.)

Item	Impacted Area	Control Area
Average Catch (kg.)	810	1224
Fish kept for home consumption (kg.)	67	103
Quantity sold (kg.)	743	1121
Mean value (weighted average) Tk./kg.	23	32.6
Gross income (Tk.)	18630	39902
Boat costs-upkeep and depreciation	509	650
Fishing gear repairs and replacements	1638	2280
Licences, leases, other costs	603	7700
Total costs	2750	10630
Net Income	15880	29272

Source: FAP 12 PIE Household Survey

The disparity in costs and earnings between fishermen of the two areas suggests that they are probably using different kinds of nets and/or that different arrangements obtain as regards payment for catching fish from ponds. It is known that some fishermen are paid a simple fee - in cash or kind or both - whilst others purchase all the fish from the pond owner and take them to a market for sale at a profit. It was impossible to include all such matters in the survey questionnaires and this again points to the need for more purposeful studies of the fisheries sector to parallel the implementation of projects such as the Chalan Beel polders, to monitor the pre-, pending- and post-project situations.

6.1.3 Employment

Table 6-2 above has already indicated the present level of employment in fishing obtained by an average fishermen in a year. The table indicates a strong possibility of widespread unemployment among fishermen during the lean period.

The involvement of family members in fishing was investigated, as shown in Table 6.8.

Table 6.8 Involvement of Family Members in Fisheries Work
(Percentage of Total Fisheries Related Work by Members)

Type of work	Impacted Area	Control Area
Men		
Fish Catching	21	21
Boat and Gear repairs	32	35
Fish processing	7	3
Fish trading	20	19
Women and Children		
Fish Catching	1	-
Boat and Gear repairs	15	20
Fish processing	3	2
Fish trading	1	-
Total percentage	100	100

Source: FAP 12 PIE Household Survey

Although there is very little difference between the two areas, the results are of interest in that they show that:

i. fishermen spend as much time in fish trading as they do in catching fish;

ii. very little fish processing takes place since most fish are sold fresh;

iii. women and children have a crucial role in maintaining fishing nets and other equipment, but interestingly are excluded from any involvement in fish trading.

6.2 FISH FARMING

6.2.1 Extent of Fish Farming

The problem of general lack of current data applies to fish farming, as well as to other sections of the fishing industry. Information on the numbers, cultivable status and distribution of fish ponds in project areas is generally unknown, although some Upazila fishery offices do keep partial data and have provided estimates. For purposes of the PIE, background data was collected as shown in Table 6.9. The figures indicate the average pond size to be quite small, invariant between the two areas and in most cases jointly owned. The latter is widely believed to be a major hindrance in the use of ponds for fish farming.

Table 6.9 Numbers of Ponds and Ownership Status

Indicators	Impacted Area	Control Area
No. of pond owners Interviewed	32	8
No. of Ponds involved	43	11
Area of Ponds owned (ha.)	10.4	3.6
Average Pond size (ha.)	0.2	0.3
Single Owner ponds (no.)	12	2
Jointly owned ponds (no.)	31	9
Estimated total pond area (ha.)	910.0	150.0

Source: FAP 12 PIE Household Survey

6.2.2 Reasons for Fish Farming

The reasons for pond excavation and their present utilisation were examined as shown in Table 6.10.

Table 6.10 Reasons for Pond Excavation and Use
(Nos. of respondents)

Reasons	Impacted Area	Control Area
Ponds excavated		
- for fish culture	13	4
- for house construction	8	1
- for other purposes	2	1
Pond Utilisation		
- for fish culture only	2	2
- also for household use	29	5
- also for livestock	8	1
- also for irrigation	4	3
Total No. of respondents	32	8

Source: FAP 12 PIE Household Survey

Earlier studies have confirmed that in the past many ponds were excavated to provide material for the household mound and to serve as a water source for household purposes. Fish production was an incidental benefit and only rarely a prime objective. The RRA study in Chalan Beel found evidence of new pond construction in several parts of the project area. It is of interest to note therefore, from the above table, that fish culture is now an established objective for constructing or re-excavating a pond, but it also appears that very few ponds are being used exclusively for that purpose.

It will prove necessary in future, if higher levels of culture intensification and productivity are to be realised, to introduce much higher standards of pond hygiene and water quality than is currently possible with such multi-use practices. The pattern of pond use appears to be much the same in the project and control areas.

6.2.4 Flood Risks

The vulnerability of ponds, to being over-flooded has been a major disincentive to fish farming development. The situation in Polder D was ascertained as detailed in Table 6.11.

Table 6.11 Pond Owners Assessment of Flooding Risks
(Nos. of respondents)

	Impacted Area	Control Area
Ponds subject to flooding before	18	2
Ponds still subject to flooding	12	2
Total respondents	32	8

Source: PIE survey

It is apparent that a large proportion of ponds within Polder D are still at risk of flooding and therefore cannot reasonably be expected to sustain more than the current levels of fish productivity unless and until the internal flooding problem is resolved. The control area is in the process of being embanked and should therefore improve in this respect in future.

6.2.5 Pond Productivity

Average productivity of fish ponds in the Chalan Beel area was investigated, with the results shown in Table 6.12

Table 6.12 Average Production of Fish Ponds
(kg./ha.)

Species	Impacted Area	Control Area
Carps	653	534
Catfish	5	4
Tilapia	4	11
Shrimp	7	-
Other spp.	15	21
Total	594	570

Source: FAP 12 PIE Household Survey

These results suggest little difference between the impacted and control areas, but both show disappointingly low productivity rates, compared with the current national average of around 1400 kg./ha..

Two reasons for poor results for fish farming which were identified during the RRA phase were the general lack of low cost rural credit to facilitate the rehabilitation of derelict ponds and the excavation of new ones, and secondly the calibre and coverage of the DOF extension service. It was not possible to include an investigation of credit availability and the record of past credit schemes as regards loan recovery rates, etc., although the performance of fish farmers versus other rural credit clients would be an interesting and very useful subject for more detailed study. Opinion regarding the effectiveness of extension service was canvassed however, with the results shown in Table 7.13.

Table 6.13 Effectiveness of DOF Aquaculture Extension Work
(Nos. of respondents)

	Impacted Area	Control Area
Extension effort has improved	10	-
Remains about the same	20	2
Extension is worse now	1	
Total respondents	32	8

Source: FAP 12 PIE Household Survey

It is a little difficult at first to reconcile the indicated improvement in extension effort with persisting low levels of fish pond productivity compared to other parts of the country. There were also too many "don't knows" in the control area for any meaningful comparison in this regard. But note that in the impacted area the immediate result of an improved extension may have been in the direction of encouraging people to use their ponds for fish farming rather than improving the productivity.

Nevertheless, the response to questions about trends in farmed fish production in the areas produced a somewhat similar picture, as shown in Table 6.14.

Table 6.14 Trends in Farmed Fish Production
(Nos. of respondents)

Extent of Change	Impacted	Control
Increased more than 25%	5	1
Increased upto 25%	5	1
Not changed	14	3
Decreased upto 25%	4	
Decreased more than 25%	2	1
Total respondents	32	8

Source: FAP 12 PIE Household Survey

Amongst the reasons for improved yields, pond owners cited protection against flooding, higher fish prices and therefore increased profitability of ponds, and the availability of good fish seed. It is probable that such ponds are situated in parts of the polder which enjoy greater protection against flooding since the project was implemented. The impression during the RRA was that ponds are more numerous in the southern part of Mohanpur area where flood risks are lower.

Other pond owners, less fortunate, cited the causes of decreased yield as embankment breaches, drainage water stagnation and fish mortalities due to disease, especially from the epidemic of "Ulcerative Syndrome" fish disease now affecting many parts of Bangladesh.

6.2.6 Profitability in Fish Farming

The profitability of fish ponds appears to be on the increase because of fish supply shortages and rising prices, and because of improved technology and better yields. The situation in the Chalan Beel area is recorded in Table 6.15.

Table 6.15 Average Fish Pond Profitability
('000 Tk./ha.)

	Impacted Area	Control Area
No. of interviews	32.0	8.0
Average sales income	19.6	17.8
Average costs; for stocking, feeding and harvesting ponds	7.6	6.2
Average net income	12.0	11.6

Source: FAP 12 PIE Household Survey

The financial return in both cases is about the same, reflecting the persisting high flood risk, and is only about 30 per cent, of the average return in the other PIE areas which are much closer to the national average. If the flooding problem can be solved there could well be a near explosive response from Chalan Beel pond owners who could easily triple their production and profit.

6.3 FISH MARKETING

Only 3 purposively selected traders could be interviewed, one per market, in the project area and 3 in the control area. This is hardly a representative sample of fish traders in the two areas.

Very little information is recorded about fish marketing in Bangladesh and DOF annual fisheries statistics contain virtually no data on the numbers of fish traders or on their activities. In Chalan Beel, as in other areas, it was found that many traders operate at several markets during the course of a month, both within and outside project impacted areas.

In the course of their travels they meet and speak to many fishermen and other traders and are therefore likely to be knowledgeable about seasonal changes and longer term trends in fish production. In addition, as shown earlier, numbers of fishermen are also taking up fish trading on a part-time basis. Probably because of this trend, there has been a considerable increase in the numbers of traders attending markets, by more than 100 per cent in both project and control areas.

As with the increase in numbers, fish traders have many problems which are unrelated to the impacts of FCD and which are therefore not reported here, although many of the issues are analysed in Appendix J of the FAP 12 Final Report. The importance of the traders' contribution, from their general knowledge of the industry, is to provide separate confirmation of some of the trends and impacts previously reported by fishermen and fish farmers.

Probably as a consequence of the increase in numbers of traders, the quantity of fish handled per trader has decreased by 25 to 30 per cent in both the impacted and control areas. However, despite the increase in trader numbers the daily volume of fish traded at each market has also decreased by more than 60 per cent in the impacted area, but by only about 30 per cent in the control area markets.

The changes in abundance of various fish species in the Chalan Beel area which were described by traders broadly confirm the fishermen's reports about decreases in stocks and yields of all the species above. However, the traders do not appear to acknowledge any significant increase in carp production as suggested by some of the fishermen.

Most of the traders considered that the two principal causes of the decline in fish production were the blockage of fish migration routes by FCD structures and the additional fish mortality resulting from fish disease.

It proved impossible to obtain credible details of fish prices which prevailed prior to the project, although current price details seemed seasonably consistent with information from other sources and are tabulated in Appendix J of the FAP 12 Final Report.

6.4 PROJECT IMPACT ON PRODUCTION

The overall estimated outcome of the Project, in terms of fish production losses and gains is set out in Table 6.16.

It is clear that of the estimated loss, nearly three-fourths are due to loss in Beel fisheries. So far only very little of the loss could be recouped with the pre-Project annual estimated catch of nearly 3300 mt. Indeed the loss may be more severe in the long run if the loss in stocking capacity is considered.

6.5 CONCLUSIONS

The overall conclusions concerning the impact of FCD on fisheries in Chalan Beel Polder D are that the polder, along with all the other interlocking polder development in the Atrai/Barnai basin, has caused a devastating decline in open water capture fisheries in the surrounding rivers and internal beels. This in turn has resulted in numbers of former fulltime fishermen having to leave fishing altogether or to continue on a part time basis only.

Unfortunately the compensating benefit from FCD, of an improved flood-free environment to encourage the development of fish farming, has very largely not materialised in Polder D, because of recurrent problems of internal flooding caused by embankment breaches, public cuts and rainwater drainage congestion. Many ponds are still at risk of flooding and in consequence pond productivity is still very low.

Table 6.16 Chalan Beel/Polder D - Fishery Losses and Gains Per Year

1. Area Data

Gross area = 53055 ha (37235 ha net)			
Estimated floodland area was 19400 ha.			
Area of floodland now drained	3000 ha.	to	5600 ha.
Area of remaining floodland	16400 ha.	-	13800 ha.
Area of beels, was about 6000 ha.			
Area of beels, now 1600 ha., to 4000 ha	2000 ha.	-	4400 ha.
Area of beels, remaining	4000 ha.	-	1600 ha.
Area of internal khals	760 ha.	-	760 ha.
Area of external rivers (shared 50:50)	1330 ha.	-	1330 ha.
133 km. X 200 m. % 2			

2. Fishery losses

a) Floodplain fully drained,	@ 73 kg./ha.	111 mt.	-	207 mt.
b) Floodplain still flooded,	@ 20 kg./ha.	328 mt.	-	276 mt.
c) Perennial beels drained,	@ 400 kg./ha.	800 mt.	-	1760 mt.
d) Beel areas remaining,	@ 150 kg./ha.	600 mt.	-	240 mt.
e) Internal khals etc.	@ 15 kg./ha.	11 mt.	-	11 mt.
f) External rivers -	@ 15 kg./ha.	20 mt.	-	20 mt.
		1870 mt.		2514 mt.

3. Culture Fishery Gains

Area of cultivated ponds increased from 300 ha. to 1030 ha., but 37% still flood prone.
Average productivity only 590 kg./ha.

therefore gain is 730 X 590	431 mt.	-	431 mt.

4. Net Loss

Low	High
1439 mt.	2083 mt.

7 IMPACT ON NON-FARM ECONOMIC ACTIVITIES

7.1 INTRODUCTION

Agricultural growth is expected to give rise to growth in non-farm activities. Since the projects studied by FAP 12 have in most cases had some positive impacts on agricultural output, it is expected that there would be some linkage effects on non-farm activities. However, since these effects are mostly indirect and given that there always exist so many variables influencing the changes, there are obviously serious problems in segregating the impacts attributable fully or directly to the projects.

Non-farm activities in rural areas are essentially the small and rural industrial activities. In dealing with such activities during PIE case studies, we have not considered activities under fishing, livestock and forestry - the first two of which have been explicitly investigated. The sample includes trading activities (e.g. dealing in rice and agricultural inputs), shop keeping and transport businesses (e.g. rickshaw, rickshaw van, boat). During the RRAs first hand information was collected on the trends of change, through direct observation and interviews with informed sources, while during the PIEs short case studies were conducted in each of the PIE areas in order to substantiate the findings obtained during the RRAs and to provide further insights into various aspects of change.

During the case studies the key aspects investigated were, among others, level (number of units) of activities, seasonality, employment (annual person days worked), production, income and demand. Given that there is a wide range (more than 60) of non-farm activities by type, selection of a limited number of sample enterprises posed some problems. Respondents were purposively selected from all the major activities in each area and thus the sample is believed to be representative of the non-farm economy in the project areas as a whole.

Additionally, given that non-farm activities widely vary in capital intensity, scale, and employment, and given that the sample was small and the survey was brief, it has not been possible, in many cases, to perform comparisons between enterprise types. In view of this, the information provided in some of the tables is indicative and provides only a general picture of the present state of non-farm activities in the study area. Annual return figures, however, have been standardised in the form of returns to family labour and management. This approach avoids the problem of imputing a wage rate for family labour, much of which is part-time and remunerated at levels well below the market wage.

7.2 TYPES OF ACTIVITIES

The Chalan Beel area generally supports a variety of non-farm activities based mainly on local resources and skills. The important activities include, among others, rice milling, wood and bamboo products, boat making, blacksmithing, fish fry marketing, rice trading, agricultural input marketing, transport and earthwork.

7.2.1 Rice and Oil Milling

Mechanised rice milling in the project areas has increased substantially. Small husking mills run on a part time basis and in off-seasons have also registered quite a significant increase. These small hullers are usually powered by STW engines and their use for milling is correlated with the spread of minor irrigation. With the growth of rice mills, obviously, the traditional method of rice husking by *dheki* has largely declined. As in most other FCD/I projects, the project areas have shown a decline in oil presses, especially the manually operated units, presumably because of general decline in oil seeds production in the project area.

7.2.2 Output and Input Trading

Like rice milling, trading in general and rice trading in particular have increased. The number of '*Kutials*' engaged in processing of rice appears to have increased considerably. With the increased use of agricultural inputs such as fertilizers, seeds and pesticides, trading in such items has registered a marked increase. Similarly with the increase in culture fishery, the number of fish fry traders has increased.

7.2.3 Agricultural Tools and Implements

The activity of producing agricultural tools and implements, made of wood and bamboo, in the form of containers, winnowers, hoes, yokes, ploughs appears to have shown a moderate growth. However, the activity of Boat making in this project area, unlike in many other FCD/I projects, has experienced a significant growth, presumably because of the use of low cost engines (mostly STW) with traditional country boats which is becoming increasingly popular. It is difficult, however, to associate growth in STW engines with FCD/I Projects since these are mainly used for irrigation in the dry season.

7.2.4 Transportation

The improvement in communications created through long embankments and a large number of link roads has actually facilitated a widespread increase in the number of simple low-cost transport means,such as rickshaws and rickshaw vans. Although there has been a growth in boat making activity, paradoxically, however, the project has had a clear negative impact on the number of boatmen in the project areas.

7.2.5 Growth of Non-Farm Activities

Table 7.1, based on the community survey conducted during PIE, gives some idea on the growth of a selected few non-farm activities. As can be seen from the table, the relative increase in the number of rice mills and agricultural input traders has been higher in the impacted areas, compared to the control areas. Although there has been increased use of mechanised irrigation and cultivation, there has been no growth in engineering workshops in the project area, whereas such workshops, catering for spares, have considerably increased in number in the control area. This is consistent with the earlier finding (Section 2.6.3) that these are for more STWs in the control area. Understandably, however, oil press units have not shown any growth in the project areas, as against remarkable growth in the control areas.

Table 7.1 : Growth of Selected Non-farm Activities

Activities	No. of units			
	Impacted (23 mouzas)		Control (12 mouzas)	
	Before	After	Before	After
Rice Mill	7	31	9	29
Oil Press	1	1	1	4
Saw Mill	1	1	2	8
Light Engg. Workshop	1	1	3	9
Ag. Input marketing	3	21	5	10

Source : FAP 12 PIE Community Survey.

7.3 THE CASE STUDIES

The present case study on Chalan Beel Polder D was conducted in both impacted and control areas. In all, the sample included 33 enterprises, of which 15 were in the impacted area and 18 in the control area. Because of the purposive nature of sampling, rigorous statistical analysis and tests have not been attempted.

Table 7.2 shows the distribution of enterprises by type and by age. As can be seen from the table, most of the enterprises were established at a time before the project was implemented. The average age of the enterprises is about 19 years for the impacted areas and 13 years for the control area. The table reveals considerable age variations among the enterprises. On the average, the enterprises of pottery, carpentry, blacksmithy, goldsmithy, and tailoring are relatively older than other types.

Table 7.2 Sample Enterprises by Type by Age

Activities	No. of units established							
	Impacted				Control			
	Before	After	Total	Average age (Yrs)	Before	After	Total	Average age (Yrs)
Rice milling	-	1	1	1	1	-	1	15
Wood, Cane & bamboo works	2	1	3	8	2	-	2	16
Furniture making	-	1	1	2				
Boat making	1	-	1	8		-		
Pottery making	1	-	1	30	1	-	1	18
Blacksmithy	1	-	1	14	1	-	1	25
Goldsmithy	-	-	-	-	1	-	1	23
Tailoring	-	-	-	-	1	-	1	20
Carpentry	-	-	-	-	2	-	2	21
Rice trading	-	1	1	1	1	-	1	12
Stationary/Grocery	1	-	1	3	2	1	3	4
Fish trading	1	-	1	6				
Fish fry trading	2	-	2	17				
Puffed rice making	-	-	-	-	1	-	1	5
Pottery trade	-	-	-	-	1	-	1	15
Rickshaw repairing	-	-	-	-	1	-	1	2
Rickshaw pulling	-	1	1	2	1	-	1	16
Boatmen	1	-	1	12	1	-	1	5
All	11 (73)	4 (27)	15 (100)	9	17 (94)	1 (6)	18 (100)	13

7.4 SEASONALITY OF PRODUCTION

Tables 7.3 and 7.4 show the distribution of enterprises by various lengths of duration of their activities, for impacted and control areas respectively. It can be seen from the tables that 6 out of 12 enterprise types (i.e. 50 per cent) in the impacted areas, and 6 out of 14 enterprise types (i.e. 57 per cent) in the control areas are run year round. The remaining 50 per cent in the impacted areas are run up to a period between 5 and 11 months; and 43 per cent in the control areas are run up to a period between 7 and 11 months. It can also be seen from the tables that very few of the enterprises has shown any change in their length of duration of activity at present compared to that in the pre-project period. This is true in both impacted and control areas.

Table 7.3 Period of Operation of Activities by Peak and Lean Season - Impacted Area

Activities	Period of Operation (months)					
	Peak Period		Lean Period		Total	
	Before	After	Before	After	Before	After
Rice milling	NA	1.0	NA	10.0	NA	11.0
Puffed rice milling	-	-	-	-	-	-
Wood, Cane & bamboo works	4.7	4.7	5.3	5.3	10.0	10.0
Furniture making	NA	3.0	NA	9.0	NA	12.0
Boat making	5.0	5.0	2.0	2.0	7.0	7.0
Pottery	6.0	6.0	6.0	6.0	12.0	12.0
Blacksmithy	7.0	7.0	5.0	5.0	12.0	12.0
Goldsmithy	-	-	-	-	-	-
Tailoring	-	-	-	-	-	-
Carpentry	-	-	-	-	-	-
Rice trading	NA	9.0	NA	3.0	NA	12.0
Stationary/Grocery	6.0	6.0	6.0	6.0	12.0	12.0
Fish trading	2.0	2.0	2.0	5.0	4.0	7.0
Fish fry trading	3.0	2.5	1.0	2.5	4.0	5.0
Pottery products marketing	-	-	-	-	-	-
Rickshaw repairing	-	-	-	-	-	-
Rickshaw pulling	NA	9.0	NA	3.0	NA	12.0
Boatmen	4.0	4.0	3.0	3.0	7.0	7.0

Source : PIE Case Studies

Table 7.4 Period of Operation of Activities by Peak and Lean Season - Control Area

Activities	Period of Operation (months)					
	Peak Period		Lean Period		Total	
	Before	After	Before	After	Before	After
Rice milling	4.0	4.0	8.0	8.0	12.0	12.0
Puffed rice milling	8.0	8.0	4.0	4.0	12.0	12.0
Wood, Cane & bamboo works	4.5	4.5	6.5	6.5	11.0	11.0
Furniture making	-	-	-	-	-	-
Boat making	-	-	-	-	-	-
Pottery	7.0	7.0	5.0	5.0	12.0	12.0
Blacksmithy	6.0	6.0	6.0	6.0	12.0	12.0
Goldsmithy	5.0	5.0	6.0	7.0	11.0	12.0
Tailoring	5.5	5.0	7.0	7.0	12.0	12.0
Carpentry	7.0	5.5	3.5	3.5	9.0	9.0
Rice trading	7.0	7.0	4.0	4.0	11.0	11.0
Stationary/Grocery	3.0	4.0	4.7	7.3	7.7	11.3
Fish trading	-	-	-	-	-	-
Fish fry trading	-	-	-	-	-	-
Pottery products marketing	2.0	2.0	5.0	5.0	7.0	7.0
Rickshaw repairing	NA	3.0	NA	9.0	NA	12.0
Rickshaw pulling	3.0	3.0	9.0	9.0	12.0	12.0
Boatmen	5.0	5.0	3.0	3.0	8.0	8.0

Source : PIE Case Studies.

7.5 EMPLOYMENT

Growth in the rice mills has given rise to employment opportunities in the impacted area. However, the employment in small rice hullers, operated with STW engines is not fully attributable to the project. With the growth of rice mills, a large female labour force, previously employed in traditional methods of rice husking, has been displaced (see section on Gender Impact). The activity of rice trading, has at least partly been able to support employment of, in particular, these displaced and distressed women through rice processing. The increased intensity of cultivation, having linkages with input supply and growth in rice mills and rice trading, has eventually created some additional non-farm employment opportunities. AS noted earlier, this increase in intensity is not a project imput.

The improved communication net work has facilitated marketing of crops, vegetables and other merchandise and thereby created part-time and full-time employment in small scale trading and road transports. Construction of embankments and their maintenance have helped creating short time non-farm employment opportunity in the form of earthworks.

As regards employment in terms of working days, Tables 7.5 and 7.6 show that 5 out of 12 (i.e 42 per cent) enterprise types in the impacted areas are run for more than 300 days a year at present. The corresponding number for the control areas is 8 out of 14 (i.e. 57 per cent). A comparison between pre and post-project periods shows that no change in the number of working days has taken place except that there has been some increase in case of blacksmithy (+10 per cent), boat making (+29 per cent), fish trading (+400 per cent) and fish fry trading (+41 per cent), and a slight decline in case of wood works (-2 per cent) in the impacted areas. For control areas, however, goldsmithy and grocery shops are the only activity presently run for a slightly longer period than before. Information on pre-project period road transport in the impacted areas is not available , but the working days for boatmen have not experienced any change neither in the impacted nor in the control areas.

From information presented in Tables 7.7 and 7.8, it is evident that the enterprises by and large are family based enterprises. The incidence of hired workers, however, for boat making, furniture, fish fry trading and boatmen in the impacted areas is quite high. In the control areas, rice milling, rice trading, goldsmithy and boatmen employ more hired workers compared to those in the impacted area. As regards present state of person days employed in various activities, the tables reveal that compared to the control areas most of the enterprises in the impacted areas employ fewer person days.

Table 7.5 Working Days of Activities by Season - Impacted Area

Activities	Days of operation during						
	Peak Period		Lean Period		Total		Change (%)
	Before	After	Before	After	Before	After	
Rice milling	NA	120	NA	120	NA	240	-
Puffed rice milling	-	-	-	-	-	-	-
Cane & bamboo works	135	135	94	90	229	225	-2
Furniture making	90	90	270	270	360	360	nil
Boat making	120	150	20	30	140	180	+29
Pottery	180	180	24	24	204	204	nil
Blacksmithy	200	210	100	120	300	330	+10
Goldsmithy	-	-	-	-	-	-	-
Tailoring	-	-	-	-	-	-	-
Carpentry	-	-	-	-	-	-	-
Rice trading	NA	270	NA	60	NA	330	-
Stationary/Grocery	180	180	180	180	360	360	nil
Fish trading	8	20	-	20	8	40	+400
Fish fry trading	22	33	10	12	32	45	+41
Pottery products marketing	-	-	-	-	-	-	-
Rickshaw repairing	-	-	-	-	-	-	-
Rickshaw pulling	NA	270	NA	45	NA	315	-
Boatmen	120	120	45	45	165	165	nil

Source : PIE Case Studies

Table 7.6 Days of Operation of Activities by Season - Control Area

Activities	Days of operation during						
	Peak Period		Lean Period		Total		Change (%)
	Before	After	Before	After	Before	After	
Rice milling	120	120	240	240	360	360	nil
Puffed rice milling	240	240	120	120	360	360	nil
Cane & bamboo works	120	110	240	240	360	350	-3
Furniture making	-	-	-	-	-	-	-
Boat making	-	-	-	-	-	-	-
Pottery	210	210	150	150	360	360	nil
Blacksmithy	180	180	120	120	300	300	nil
Goldsmithy	150	150	180	210	330	360	+9
Tailoring	150	150	105	105	255	255	nil
Carpentry	138	138	39	39	177	177	nil
Rice trading	210	210	120	120	330	330	nil
Stationary/Grocery	90	120	140	120	230	240	+4
Fish trading	-	-	-	-	-	-	-
Fish fry trading	-	-	-	-	-	-	-
Pottery products marketing	60	60	100	100	160	160	nil
Rickshaw repairing	NA	45	NA	63	NA	108	-
Rickshaw pulling	78	78	234	234	312	312	nil
Boatmen	75	75	45	45	120	120	nil

Table 7.7 Per Enterprise Employment and Annual Person Days Employed (After the Project) - Impacted Area

Activities	Average employment			Annual person days employed		
	Family	Hired	Total	Family	Hired	Total
Rice milling	1.0	1.0	2.0	240	240	480
Puffed rice milling	-	-	-	-	-	-
Wood, Cane & bamboo works	1.0	0.3	1.3	225	75	300
Furniture making	1.0	2.0	3.0	360	720	1080
Boat making	1.0	9.0	10.0	180	1620	1800
Pottery	3.0	-	3.0	612	-	612
Blacksmithy	2.0	-	2.0	660	-	660
Goldsmithy	-	-	-	-	-	-
Tailoring	-	-	-	-	-	-
Carpentry	-	-	-	-	-	-
Rice trading	1.0	-	1.0	330	-	330
Stationary/Grocery	2.0	-	2.0	720	-	720
Fish trading	2.0	-	2.0	80	-	80
Fish fry trading	2.0	4.0	6.0	90	180	270
Pottery products marketing	-	-	-	-	-	-
Rickshaw repairing	-	-	-	-	-	-
Rickshaw pulling	1.0	-	1.0	315	-	315
Boatmen	1.0	2.0	3.0	165	330	490

Source : PIE Case Studies

Table 7.8 Per Enterprise Employment and Annual Person Days Employed (After the Project) - Control Area

Activities	Average employment			Annual person days employed		
	Family	Hired	Total	Family	Hired	Total
Rice milling	1.0	2.0	3.0	360	720	1080
Puffed rice milling	1.0	2.0	3.0	360	720	1080
Wood, Cane & bamboo works	1.0	-	1.0	350	-	350
Furniture making	-	-	-	-	-	-
Boat making	-	-	-	-	-	-
Pottery	1.0	-	1.0	360	-	360
Blacksmithy	2.0	-	2.0	600	-	600
Goldsmithy	1.0	2.0	3.0	360	720	1080
Tailoring	1.0	1.0	2.0	255	255	510
Carpentry	1.5	1.0	2.5	266	177	443
Rice trading	1.0	4.0	5.0	330	1320	1650
Stationary/Grocery	2.0	-	2.0	480	-	480
Fish trading						
Fish fry trading						
Pottery products marketing	1.0	-	1.0	160	-	160
Rickshaw repairing	2.0	-	2.0	216	-	216
Rickshaw pulling	1.0	-	1.0	312	-	312
Boatmen	1.0	3.0	4.0	120	360	480

Source : PIE Case Studies

7.6 PRODUCTION AND INCOME

In order to obtain the trend of change, during PIE case studies the respondent entrepreneurs were asked of the extent of change (if any), compared to the pre-project period, that has taken place in the respective production, income and demand for products.

The percentages of the enterprises reporting "increase", "decrease" or "same" are presented in Table 7.9. The resultant changes (positive or negative) in production and income having been weighted with corresponding individual figures, are presented in the last column of the table.

As can be seen from the table, about 54 per cent of the enterprises in the impacted areas reported increase in production, and 62 per cent reported increase both in their income and demand for their products, compared to the pre-project period. In the control areas, however, the corresponding proportions are higher, about 63 per cent reporting increase in production, and 69 per cent reporting increase in both income and demand for products. Nevertheless, there has not been any marked change in the actual overall production of all types of enterprises taken together, by only 2.1 per cent increase in the impacted areas as against a 1.7 per cent decline in the control areas. As regards overall income, again the enterprises in the impacted areas have shown an increase by 1.2 per cent as against a decline by 0.7 per cent in the control areas.

Table 7.9 Changes in Production, Income and Demand for Products (Compared to Pre-project Period)

Item	Area	% of enterprises reporting			Actual change (%)
		Increase	Decrease	Same	
Production	Impacted	53.8	30.8	15.4	2.1
	Control	62.5	25.0	12.5	-1.7
Family Income	Impacted	61.5	38.5	-	1.2
	Control	68.8	25.0	6.2	-0.7
Demand for Products	Impacted	61.5	38.5	-	-
	Control	68.8	25.0	6.2	-

Source : PIE Case Studies.

Family Income = Value of annual output *minus* annual cost of raw materials and wage bills to hired labourers.

Table 7.10 presents information on per enterprise annual income, at present, from selected non-farm activities. Following that the enterprises under study vary widely in capital, scale and employment, and that not all types of enterprises are common in the sample of both easily impacted and control areas, the income figures over the impacted and control areas are not comparable. However, the income figures standardised through obtaining return per family labour show that per family labour income level from the enterprises, in general, is on the low side in the impacted areas, compared to those in the control areas. The only exceptions are for the enterprises of wood and bamboo products, and rickshaw pulling.

Table 7.10 Per Enterprise Annual Family Income from Various Non-farm Activities

Activities	Annual[1] family income (Tk.)		Annual income per family labour	
	Impacted	Control	Impacted	Control
Rice milling	12180	57600	12180	57600
Puffed rice milling	-	70280	-	70280
Wood, Cane & bamboo works	18648	10040	18648	10040
Furniture making	15150	-	15150	-
Boat making	105570	-	105570	-
Pottery	9000	20600	3000	20600
Blacksmithy	25750	39000	12875	19500
Goldsmithy	-	136520	-	136520
Tailoring	-	18095	-	18095
Carpentry	-	16272	-	10848
Rice trading	9300	43424	9300	43424
Grocery/Stationary	15798	20564	7899	10282
Fish trading	18700	-	9350	-
Fish fry trading	20950	-	10475	-
Pottery products marketing	-	2930	-	2930
Rickshaw repairing	-	4578	-	2289
Rickshaw pulling	16530	10665	16530	10665
Boatmen	8541	23400	8541	23400

Source : FAP 12 PIE Case Studies

Note : Rice milling here refers to rather large mills as opposed to rice husking done with STW engines.

7.7 PERCEPTIONS OF BENEFITS FROM THE PROJECT

During the case study, the entrepreneurs' perceptions of benefits from the project under study were recorded. The perceptions of benefits (towards development of non-farm activities) are presented in Table 7.11. As can be seen from the Table, 8 out of 15 (i.e 53 per cent) enterprises of the impacted areas mentioned that they have benefited from the project. All of the benefited enterprises appear to have benefited by way of easy transportation; about half of the enterprises mentioned that they have benefited by way of increased supply of raw material and increased demand for output.

Table 7.11 Entrepreneurs' Perceptions of Benefits from the Project

Type of benefit	% of benefited respondents
Eased transportation of raw material and output	100.0
Increased supply of raw material	50.0
Increased demand for output	50.0
Others	-
Benefited respondents	8
% Benefited	53

7.8 DAMAGE DURING 1988 FLOOD

The Project appears not to have reduced the risk of damaging floods (affecting infrastructure and rural industry), and in 1988 the project areas suffered more damage than outside the polder.

Table 7.12 gives information on type and extent of damage caused to enterprises by the devastating 1988 flood. As can be seen from the table, out of 15 enterprises in the impacted areas, 6 (i.e. 40 per cent) have suffered losses, as against 5 out of 18 (i.e. 28 per cent) in the control areas. Also, the extent of losses caused per enterprise is much higher inside the project (Tk.5700 per enterprise) than in the control areas (Tk.1000 per enterprise). This may be because those inside the protected areas had established their enterprises on lands that they believed were not at risk, whereas enterprises outside tended to build on higher ground in the absence of protection from probable floods.

Table 7.12 Damage Caused by 1988 Flood

Area	Total Sample	No. of units affected by 1988 flood	%	Per enterprise[1] amount of damage on account of (in Tk)					
				Structure	Machinery	Raw material	Output	Working days	Total
Impacted	15	6	40	233	84	10	4005	1370	5702
Control	18	5	28	56	-	-	31	928	1015

[1] averaged over all enterprises

8 GENDER IMPACT

8.1 INTRODUCTION

8.1.1 Limitations

There are several ways in which women and their roles vis-a-vis those of men may be affected due to flood control measures. Furthermore, women from different types of household, (farm, labour, fishermen) are likely to be affected differently and in different degrees. Then again, in a patriarchal society the outcome of any process, when it involves women, depends not only on the process itself but also on tradition and social factors which make the final outcome rather uncertain. What all these mean is that it is not possible, without a thorough investigation, to clearly understand the impact of flood control interventions on women's lives. The analyses and descriptions that follow, therefore, will only try to indicate the broad direction in which changes may have taken place, if at all, and any conclusion that may be drawn will be rather tentative, necessitating further validation.

8.1.2 The Areas of Investigation

The analyses that follow in this section fall in four broad areas, viz.,

i. nature of women's involvement in household and outside work;

ii. activities related to homestead production;

iii. nutritional issues;

iv. problems faced by women during severe floods.

In each of the areas, several issues will be picked up for focus.

8.2. NATURE OF WOMEN'S INVOLVEMENT IN HOUSEHOLD AND OUTSIDE WORK

8.2.1 Hiring of Women

In CBPD, only a few households have been found to be involved both in hiring-in and hiring-out of women to earn an income for the family. Only among the farmers does one find both hiring-in and hiring-out of women. Even among the farmers the incidence of the former is not high. In contrast to farm households, other households do not hire-in any female labour but the incidence of hiring-out is substantial among the labour households.

Table 8.1 : Employment of Women in Out-of-Home Activities in CBPD
(No. of respondents)

Type of household	Hire in		Hire out	
	Impacted	Control	Impacted	Control
Farmer	8 (13)	3 (10)	5 (8)	1 (3)
Labourer	0 (0)	0 (0)	6 (26)	5 (42)
Fishermen	0 (0)	0 (0)	0 (0)	1 (7)
ALL	8 (8)	3 (5)	11 (11)	7 (13)

Source : FAP 12 PIE Household Survey

Note : Figures in parentheses indicate percentages of total number of respondents

8.2.2 Agricultural and Non-agricultural Work

Women in farm households are involved in various agricultural works, particularly those related to crop processing (see below). Very few women from labour and fishermen households are so involved for the reason that they have little, if any land. The opposite generally holds for non-agricultural work. While very few women from farm households have been found to use their time in non-agricultural pursuits, the proportion is higher in the other categories of households. For example, in labour households, more or less half of the women have been found to be involved in non-agricultural work. One also finds that in the CBPD area proportionately more are involved in non-agricultural work in the control area compared to the impacted area.

8.2.3 Sexual Division of Work in Agricultural Activities

Prior to the construction of the embankment in the CBPD area the responsibilities of men and women in agricultural operations were generally clear-cut. Men used to be involved mostly in field-activities during the pre-harvest and harvesting periods. Women's jobs were confined mostly and not surprisingly to those which could be performed in seclusion within the household. They were thus involved in seed preservation, drying and parboiling of paddy and to a lesser extent in threshing and husking of paddy. In threshing they shared the burden with men but in parboiling and husking a few women from outside were also employed. The patterns were the same for both the impacted and the control areas.

The project did not change the basic pattern of sexual division of work. On the other hand the lack of any impressive output growth did not create much of an additional opportunity for hired women to be employed in greater numbers or proportion in the impacted area compared to the control.

In the post-project situation the work burden of women fell in the case of husking in which men are now found to be engaged more frequently than before, particularly in the impacted area. On probing, it has been found that in both cases, mechanised husking has become more common than before due to the use of STW engines for this purpose during the off-season. Only to a very limited extent could one term this a project impact in the CBPD area.

Table 8.2 : Sex-wise Role Distribution in Agricultural Work in Farm Households in CBPD (Percentage of respondents)

Activity type	Impacted						Control					
	F. Women		H. Women		Men		F. Women		H. Women		Men	
	B	A	B	A	B	A	B	A	B	A	B	A
Seed pres.	84.4	87.5	3.1	3.1	50.0	48.2	89.7	93.1	-	-	51.7	51.7
Pre-harvest	-	-	4.7	4.7	96.9	98.4	-	6.9	3.4	3.4	100.0	100.0
Harvest	-	-	3.1	3.1	98.4	100.0	-	-	3.4	3.4	96.6	96.6
Threshing	35.9	37.5	7.8	9.4	71.9	75.0	51.7	51.7	6.9	10.3	72.4	72.4
Parboiling	95.3	96.9	9.4	10.9	-	-	93.1	96.6	3.4	3.4	3.4	3.4
Husking	51.6	32.8	3.1	4.7	1.6	18.6	69.0	62.2	3.4	3.4	-	24.1
Storage	95.3	95.3	6.3	7.8	6.3	6.3	93.1	96.6	3.4	3.4	6.9	6.9

Source : FAP 12 PIE Household Survey

8.2.4 Change in Agricultural Activities of Women Family Members and Reasons Thereof in Farm Households

Several factors may influence the direction and magnitude of change in the work burden of women in agricultural activities. A rise in output, which is the case in CBPD impacted area because of a shift from B. aman to L. T. Aman, increased paddy production and the demand for the time of women in most of the activities in which they are engaged. The actual outcome in case of women from the family will, of course, depend on how much of the additional load is shared by either men or hired women labourers. There is no *a priori* hypothesis about such substitution and the final outcome therefore may be judged only empirically.

The information from CBPD area indicates that the situation is rather clear in the impacted area with increasing workloads in all activities except in the case of husking, in which more women appear to have experienced a decreasing work load than those who have experienced an increase (Table 8.3). The situation in the control area is less clear cut with almost equal numbers of households experiencing an increase and a decrease, except again in husking in which the trend is clearly downward.

Among those who could identify the reasons for the change in the impacted area, practically all ascribed it to higher output. In comparison the reasons for the decrease could in many, but not all cases, be traced to inundation from various sources, including public cuts in the embankment. Land loss is a major reason given in the impacted area. It is not clear whether the loss refers to erosion or to land loss due to other factors.

In the control area, although output growth has been a major factor, others were also important. In case of the decrease in work load, water-logging, pest attack and lower yield were all important factors.

Table 8.3 : **Changes in Activities of family Women in Agricultural Operations in CBPD** (Farm Households) (No. of respondents)

Activity type	Impacted		Control	
	Increased	Decreased	Increased	Decreased
Seed pres.	22 (34)	8 (13)	9 (31)	8 (28)
Pre-harvest	1 (2)	0 (0)	0 (0)	0 (0)
Threshing	6 (9)	5 (8)	3 (10)	5 (17)
Parboiling	26 (41)	12 (19)	11 (38)	12 (41)
Husking	2 (3)	8 (13)	0 (0)	8 (27)
Storage	22 (34)	5 (8)	7 (24)	5 (17)

Source : FAP 12 PIE Household Survey

Note : Figures in parentheses are percentages of total number of respondents.

Table 8.4 : **Reasons for Change in Women's Involvement in Agricultural Activities in Farm Households in CBPD** (No. of response)

Reasons	Impacted	Control
A. *Increase*	63	23
Higher output	58 (92)	18 (78)
Others	5 (8)	5 (22)
B. *Decrease*	49	47
Flood/water logging/rain	17 (35)	12 (25)
Land loss	14 (28)	2 (4)
Cut in emb.	6 (12)	-
More husking machines	4 (8)	2 (4)
Pest attack	2 (4)	11 (23)
Lower yield	3 (6)	8 (17)
Others	3 (6)	12 (25)

Source : FAP 12 PIE Household Survey

Note : Figures in parentheses indicate percentages of total number of response by type of change

8.3 HOMESTEAD PRODUCTION

8.3.1 Number and Types of Trees

The average number of trees including bamboos per household has risen in both the impacted and control areas but more so in the latter compared to the pre-project situation (Table 8.5). The number of trees per household is highest among the farmers as they have more land than others in and around the homesteads. In their case too one finds an increase in the average number compared to the pre-project situation but again more so in the control area. Labour households show a similar pattern. It is only among the fishermen households of the impacted area that one observes a reduction in the number of trees.

Many types of trees are grown in the homesteads. One may categorise them, however, as fruit-bearing or timber-yielding. The data from CBPD indicate that there may have been a substantial positive change over time in the proportion of the former (from 16 per cent to 27 per cent) in the impacted area. In comparison, there has been little change (36 per cent to 40 per cent) in the control area.

Table 8.5 : Average Number of Trees in and Around Homesteads in CBPD

Household type	Impacted		Control	
	Before	After	Before	After
Farmer	116	161 (39)	123	185 (50)
Labourer	9	26 (189)	19	38 (100)
Fishermen	11	9 (-18)	17	35 (106)
ALL	77	108 (40)	72	113 (57)

Source : FAP 12 PIE Household Survey

Note : Figures in parentheses indicate percentage change over the pre-project situation.

8.3.2 Sexual Division of Work in Caring for Trees

Women, whether in association with men or themselves alone, are involved in tree care and harvest. Their individual role is much more prominent compared to that of men in the case of collection of fuelwood and leaves for use as fuel. In plantation and felling of trees their role is quite limited and the individual role of men is much more prominent. This is the general pattern across all occupational groups and in both the impacted and control areas.

What may have happened over time in the relative roles of men and women in caring for trees is difficult to assess. But the percentage distribution of fruit-bearing trees and the average number of trees (of all types) have both gone up. This indicates that over time the work burden of women in general tree-care may have increased.

In actual decision making the process seems more participatory, except in tree-felling, across all the groups. One also observes that the percentage of women claiming a role in decision-making is high in all types of household and all types of decision-making (except in tree-felling). The pattern in CBPD is thus different from other places as men do seem to have less tighter control in the decision-making in this area. Women appear to be more involved in the control area compared to the impacted area. Why this should be so cannot be ascertained, however, because of a lack of more information.

Table 8.6: Incidence of Women's Role in Decision-making in Tree Plantation in CBPD
(No. and % of women responding positively)

Type of household	Plantation		Harvesting		Tree-felling	
	Imp	Cnt	Imp	Cnt	Imp	Cnt
Farmer	36 (56)	18 (62)	52 (81	26 (90)	22 (34)	16 (55)
Labourer	9 (39)	6 (50)	12 (52)	8 (67)	6 (26)	6 (50)
Fishermen	3 (20)	12 (80)	6 (40)	15 (100)	1 (7)	11 (73)
ALL	48 (47)	36 (64)	70 (69)	49 (87)	29 (28)	33 (59)

Source : FAP 12 PIE Household Survey

Note : Figures in parentheses are percentages of total number of respondents

8.3.2 Vegetable Production : Incidence and Sex Roles

Practically all households have a vegetable producing plot, usually quite tiny, no more than 1 - 2 decimals in size. It appears from the information collected in the field that in the impacted area there has been quite some reduction in the area, most noticeably among the labourers (49 per cent over the pre-project situation). In the control area there have been both a substantial rise (51 per cent) in the case of farmers and a substantial decline (37 per cent) in the case of fishermen.

For all practical purposes activities related to vegetable gardening in the homestead are a woman's domain. Men help mostly with land preparation, sowing and weeding. There appears to be little difference in the pattern between the impacted and the control areas.

8.3.3 Poultry Keeping : Relative Sex Roles

The role of women in decisions regarding poultry keeping appears to be prominent in both farm and labour households and more so in the former. There is little difference in the pattern between the impacted and the control areas (Table 8.7).

Table 8.7 : Incidence of Women's Role in Decision-making in Poultry Keeping in CBPD
(No. and % of women responding positively)

Household type	Sale		Purchase		Sale money use	
	Imp	Cnt	Imp	Cnt	Imp	Cnt
Farmer	43 (67)	21 (72)	45 (70)	21 (72)	47 (73)	22 (76)
Labourer	11 (48)	5 (42)	13 (56)	6 (50)	13 (56)	4 (33)
Fishermen	- (-)	11 (73)	- (-)	12 (80)	1 (7)	10 (67)
ALL	54 (53)	37 (66)	58 (57)	39 (70)	61 (60)	36 (64)

Source : FAP 12 PIE Household Survey

Note : Figures in parentheses indicate percentages of total number of respondents by category

8.3.4 Homestead Income and Its Use

The estimated incomes per household by type of source and type of household for the impacted and control areas are shown in Table 8.8. The over all impression one gets is that the average homestead income is higher in the impacted area compared to the control only in case of farm households where the difference is substantial. In all other cases, the aggregate average income is higher in the control area, particularly among the fishermen households.

Much of the homestead income is due to that from poultry in both the impacted and control areas and in all types of household their relative importance are similar. Indeed much of the difference in average total homestead income between the impacted and control area for a given type of household can be traced to the difference in poultry and egg income. In the case of farm households they can keep more chicken and ducks which although basically scavengers may still be better fed and cared for because of the higher agricultural output in the farm households. Then again women in farm households, being freed of the back-breaking job of paddy husking, may have more time for such activities. In the case of fishermen households a possible source of food supply is the fish waste which is likely to be more plentiful in the control than in the impacted area.

Very few households sell vegetables or poultry or eggs. Hence it is difficult to make any comment on the general pattern of sex-differences in receipt of sale money.

The homestead income accrues in kind and practically all of it is consumed by the household. Practically all who answered the question on the use of the homestead income, therefore, identified it as being spent mainly for the household. Very few seemed to have spent it for personal purposes.

Table 8.8 : Average Returns from Homestead Production in CBPD
(Tk/household/year)

Household type	Impacted				Control			
	Veg.	Pty.	Egg	All	Veg.	Pty.	Egg	All
Farmer	178 (12)	979 (64)	376 (24)	1532 (+82)	121 (14)	510 (61)	209 (25)	839
Labourer	56 (7)	532 (66)	222 (27)	810 (-16)	112 (12)	659 (69)	190 (20)	961
Fishermen	38 (9)	275 (67)	100 (24)	413 (-59)	142 (14)	544 (54)	327 (32)	1014
ALL	128 (11)	767 (64)	298 (25)	1193 (+31)	125 (14)	551 (60)	236 (26)	912

Source : FAP 12 PIE Household Survey

Note : 1. Figures in parentheses indicate percentage composition of total household income in the first three columns shown under the impacted and control areas. Those in the fourth column under the impacted area shows percentage difference over the total homestead income in the control area.

2. Veg. : vegetables; pty : poultry.

8.3.5 Group Activities

Very few women were found to be involved in group activities but comparatively more in the control area (9 in the impacted, 11 in the control). Those who had been so involved were mainly from farm households in the impacted area and from the fishermen households in the control area.

8.4 NUTRITIONAL ISSUES

8.4.1 Caveats

A rise in income of the people living in the project area, it is hoped, would lead to better nutritional levels in the households. As a full-fledged nutritional survey was not possible during the present study, the Consultants emphasised only the level of intake of major food items which are consumed most frequently (rice, wheat, parched rice and pulses) and tried to elicit women's ideas about adequacy of food intake in the family. In addition, gender-differences in rice consumption were investigated.

The four types of food mentioned above contribute nearly 84 per cent of total calorie intake (BBS; 1991) in rural Bangladesh. Using this ratio, the total calorie consumption in the sampled households was estimated. The period of field survey was immediately after the Eid-ul-Azha (festival of sacrifice) but this is unlikely to have influenced consumption pattern except perhaps for meat.

8.4.2 Food and Calorie Intake

Table 8.9 shows the estimated average consumption of rice and energy on a per capita basis. The most interesting conclusion that one may make is that in the case of calorie consumption the sample households in the CBPD area, whether in the impacted or the control area, are similar in aggregate to those in other successful projects such as Zilkar Haor or Kolabashukhali and particularly so in the case of farm and fishermen households. Furthermore, there does not appear to much of a difference between the types of household in the impacted area. In the control area, the labour households seem to be the least well-off. But the farmers and fishermen appear to be on a similar nutritional plane whether one considers rice intake or calorie consumption. On the whole there is also little difference between the impacted and control areas.

The section on socio-economic issues indicates that the incomes of households are similar in the impacted and the control areas for a given land holding size. Then again the analyses of changes in agricultural output indicate that there has been only a modest growth (nearly .3 mt) of output per household in the impacted area over the control. Thus, there is little reason, if any, for substantial difference in rice or calorie consumption between the two areas, either for farmer or other types of households.

Table 8.9 : Per Capita Daily Rice and Calorie Intake in CBPD

Household type	Rice (gms)		K calorie	
	Impacted	Control	Impacted	Control
Farmer	580 (18)	490	3110 (8)	2887
Labourer	492 (9)	450	3185 (40)	2271
Fishermen	589 (15)	511	3023 (0)	2995
ALL	566 (15)	491	3032 (11)	2731

Source : FAP 12 PIE Household Survey

Note : Figures in parentheses indicate percentage differences over control.

8.4.3 Poverty Profile

The estimated calorie consumptions were used to construct a profile of households on the basis of attainment of certain levels of calorie intake. The households were divided into three groups, viz., hard core poor (consuming at most 1805 K cal/person/day), absolute poor (consuming between 1805 and 2122 K cal/person/day) and the non-poor (consuming above 2122 K cal). The results are shown in Table 8.10.

The estimates in the table seem to further confirm the finding above that nutritionally the sample households are quite well-off in both the impacted and control areas. The proportion of non-poor households is very high in all the groups and only slightly more so in the impacted area.

Table 8.10 : Distribution of Households by Level of Poverty in CBPD
(No. of households)

Household type	Hard core		Absolute		Non-poor	
	Imp	Cnt	Imp	Cnt	Imp	Cnt
Farmer	0 (0)	2 (6.9)	2 (3.1)	3 (10.3)	62 (97)	24 (83)
Labourer	6 (26.1)	4 (33.3)	1 (4.4)	0 (0)	16 (69)	8 (67)
Fishermen	2 (13.3)	0 (0)	0 (0)	1 (6.7)	13 (87)	14 (93)
ALL	8 (7.8)	6 (10.7)	3 (2.9)	4 (7.1)	91 (89)	46 (82)

Source : FAP 12 PIE Household Survey

Note : Figures in parentheses indicate percentages of total number of respondents by category

8.4.4 Adequacy of Food Intake

The women were asked about the adequacy of food intake in the family. It does not come as surprise, given the findings discussed above, that the sense of deprivation is felt only a little among the farmers and the fishermen in general but also among the labour households in the control area (Table 8.11). Only the answers given by labour households in the impacted area indicate quite a high percentage of incidence of inadequacy. The reason is not clear and appears counter-intuitive.

8.4.5 Gender Differences in Food Intake

Two indicators of gender-differences were used, viz., the difference in rice intake of adult men and women and that between boys and girls of about 8 years of age. The latter showed only a little difference in food intake, around 400 grammes per day. In contrast, one finds an appreciable difference between the intakes of adult men and women. The women have been found to consume 20 - 25 per cent less than adult men. The deprivation seems to be of similar magnitude in both impacted and control areas.

Table 8.11 : Adequacy and Gender Differences in Food Intake in CBPD

Household type	Percent stating inadequacy		Women/men ration in rice intake (%)	
	Impacted	Control	Impacted	Control
Farmer	16	17	79	75
Labourer	61	42	76	89
Fishermen	33	20	79	81

Source : FAP 12 PIE Household Survey

8.4.6 Consumption of Non-grain Food

A rise in income of the people, one may hypothesise, will lead to increased consumption of quality foods such as meat, fish, eggs and milk as the income elasticity of such foods is high. Whether this is the case in the project areas experiencing a modest growth in output has been sought to be tested in a very crude manner by looking at the frequency of consumption of such foods. Table 8.12 shows the incidence of consumption of these types of food over the week preceding the survey. Several conclusions can be drawn. These are as follows:

- Fish appear to be the most frequently consumed non-grain food. Most farmers and all fishermen in the impacted area had consumed fish during the reference week. Among labour households, however, only about 60 per cent had been so fortunate. The situation is similar in the control area but far worse for the labour households.

- In the case of all other food, the picture appears to be mixed with no clear pattern of difference between the types of area or types of household, but the labour households appear to be the least fortunate.

Table 8.12 : Incidence of Consumption of Non-grain Food During the Last 7 Days Preceding the Survey in CBPD

Food type	Farmer		Labourer		Fishermen	
	Imp	Cont	Imp	Cont	Imp	Cont
Meat	31 (48)	5 (17)	6 (26)	1 (8)	10 (67)	5 (33)
Fish	53 (83)	23 (79)	14 (61)	4 (33)	15 (100)	15 (100)
Egg	20 (31)	9 (31)	7 (30)	3 (25)	6 (40)	8 (53)
Milk	30 (47)	11 (38)	4 (17)	1 (8)	8 (53)	10 (67)

Source : FAP 12 PIE Household Survey.

Note : Figures in parentheses are percentages of total number of respondents by category.

8.4.7 Frequency of Cooking

Practically all households in both the impacted and the control areas and all groups of households cook at least twice a day. Many also cook three times. Thus, very few people eat cold meals.

8.4.8 Incidence of Starvation

Despite a growth in annual income, people may still starve partly or fully during a part of the year because of a seasonal lack of employment and income. When asked about such incidence, the responses seems to indicate that there had been little change in the proportion of households so affected before and after the project, irrespective of impacted or control areas, for any specific occupational group (Table 8.13). Among the occupation groups, however, as may be expected the farmers are the most fortunate while most of the labourer and fishermen households have to starve during parts of the year. The incidence of starvation among the fishermen in the control area is somewhat lower than in the impacted.

Table 8.13 : Incidence of Starvation in Pre- and Post-Project Situation in CBPD
(No. of respondents)

Household type	Impacted		Control	
	Before	After	Before	After
Farmer	37 (58)	36 (56)	16 (55)	17 (59)
Labourer	22 (96)	20 (87)	10 (83)	9 (75)
Fishermen	13 (87)	12 (80)	9 (60)	8 (53)
ALL	72 (71)	68 (67)	35 (62)	34 (61)

Source : FAP 12 PIE Household Survey

Note : Figures in parentheses are percentages of total number of respondents by category.

8.4.9 Seasonality in Starvation

Starvation is related to the seasonal peaks and troughs of economic activities. Aman being the major rice, in general one expects a rise in dietary intake of farmers and labourers in general and a low incidence of starvation during this period (Bengali months of Poush and Magh). Among fishermen too this is a period of peak income both because the catches are good during the winter while the Aman harvest keeps effective demand at a high level. Where Boro is a major rice one would expect a dip again in or around May (Bengali months of Baishakh and Jaistha). Unless Aus is a major crop one would expect the level of income and employment to fall progressively then and reach their lowest levels around Kartik and just before Aman harvest begins in Agrahayan (October - November) when the incidence of starvation may be the highest.

In CBPD, as seen in the section on agriculture, the two most important crops are T. Aman and Boro in both the impacted and control areas. The incidence of Aman is much higher in the control area (39 per cent of gross cropped area compared to about 28 per cent in the impacted). Boro occupies about 30 per cent of cropped land in both the areas. Aus is relatively insignificant in both the areas. One therefore may expect two dips in the seasonality of incidence of starvation, once after and during the Boro harvest and once after and during the Aman harvest.

Figures 8.1 - 8.3 confirm the above hypotheses of the Aman period dip for all types of household. The Boro-dip, however, is not clear for the farmers although the rise after that appears to be rather muted in the impacted area. In the case of labour households in the impacted area during the pre-project situation there had been a continuous rise in the incidence of starvation till the month of Kartik after the Boro period dip. There is now a much more muted rise and indeed a dip during the full monsoon. This can be explained by the change over from B. Aman to T. Aman which creates additional demand for labour for transplantation.

In the case of fishermen, the pattern is basically similar to those for others but also exhibits high incidence of starvation during the monsoon period when the scopes for fishing in the beels is very limited while the rivers not being perennial any more does not offer opportunities for fishing.

8.4.10 Adjustment Mechanisms

When the prospects of starvation loom large, people mostly either borrow from others or try to eat less or do both (Table 8.14). This is true across all groups of households and in both impacted and control areas.

The burden of internal adjustments seems to fall somewhat disproportionately on women and more so in the farm households. In the latter case while in a quarter of the households in the impacted area everyone in the family shares the hunger, in 12 per cent at cases only women alone have to do so. What these findings clearly bear out is that a general rise in the economic well-being in the family may be no guarantee to women's sharing the burden of distress equitably with their men counterparts.

Table 8.14 : Measures to Cope with Starvation in CBPD

(No. and % of response)

Type of measure	Farmer		Labourer		Fishermen		ALL	
	Imp	cnt	Imp	Cnt	Imp	cnt	Imp	Cnt
Borrowing	23 (36)	11 (38)	11 (48)	6 (50)	11 (73)	5 (33)	45 (44)	22 (39)
All ate less	17 (27)	11 (38)	16 (69)	8 (67)	7 (47)	6 (40)	40 (39)	25 (45)
Women ate less	8 (12)	4 (14)	2 (9)	- (-)	2 (13)	2 (13)	12 (12)	6 (11)
Others ate less	- (-)	- (-)	1 (4)	1 (8)	- (-)	- (-)	1 (1)	1 (2)
Disinvestment	10 (16)	3 (10)	8 (35)	2 (17)	- (-)	1 (7)	18 (18)	6 (11)
Others	3 (5)	5 (17)	2 (9)	4 (33)	2 (13)	2 (13)	7 (7)	11 (20)

Source : FAP 12 PIE Household Survey

Note : Figures in parentheses indicate percentages of total number of responses by category of household

Figure 8.1 Starvation in Chalan Beel Polder D (Farmers)

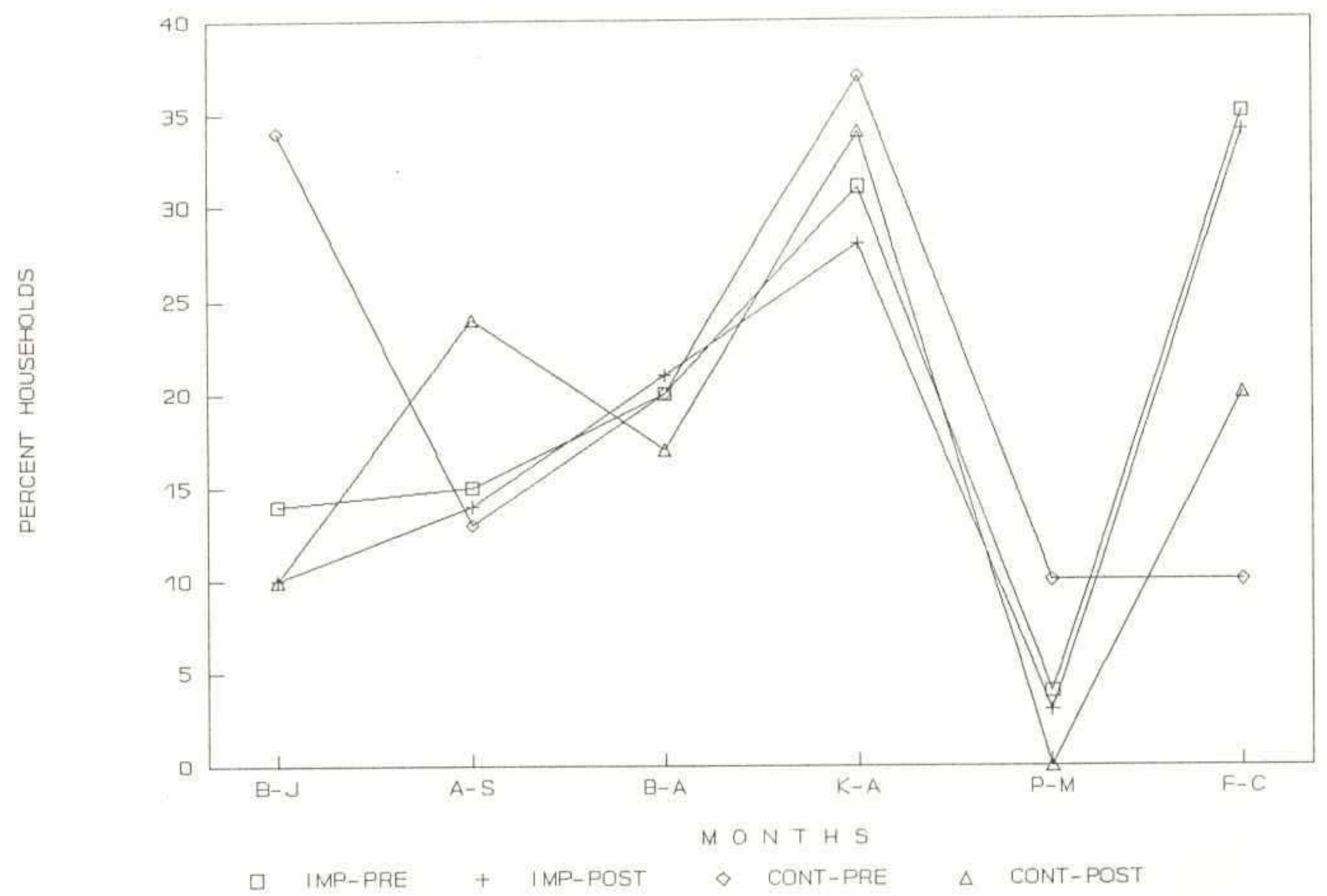


Figure 8.2 Starvation in Chalan Beel Polder D (Labourers)

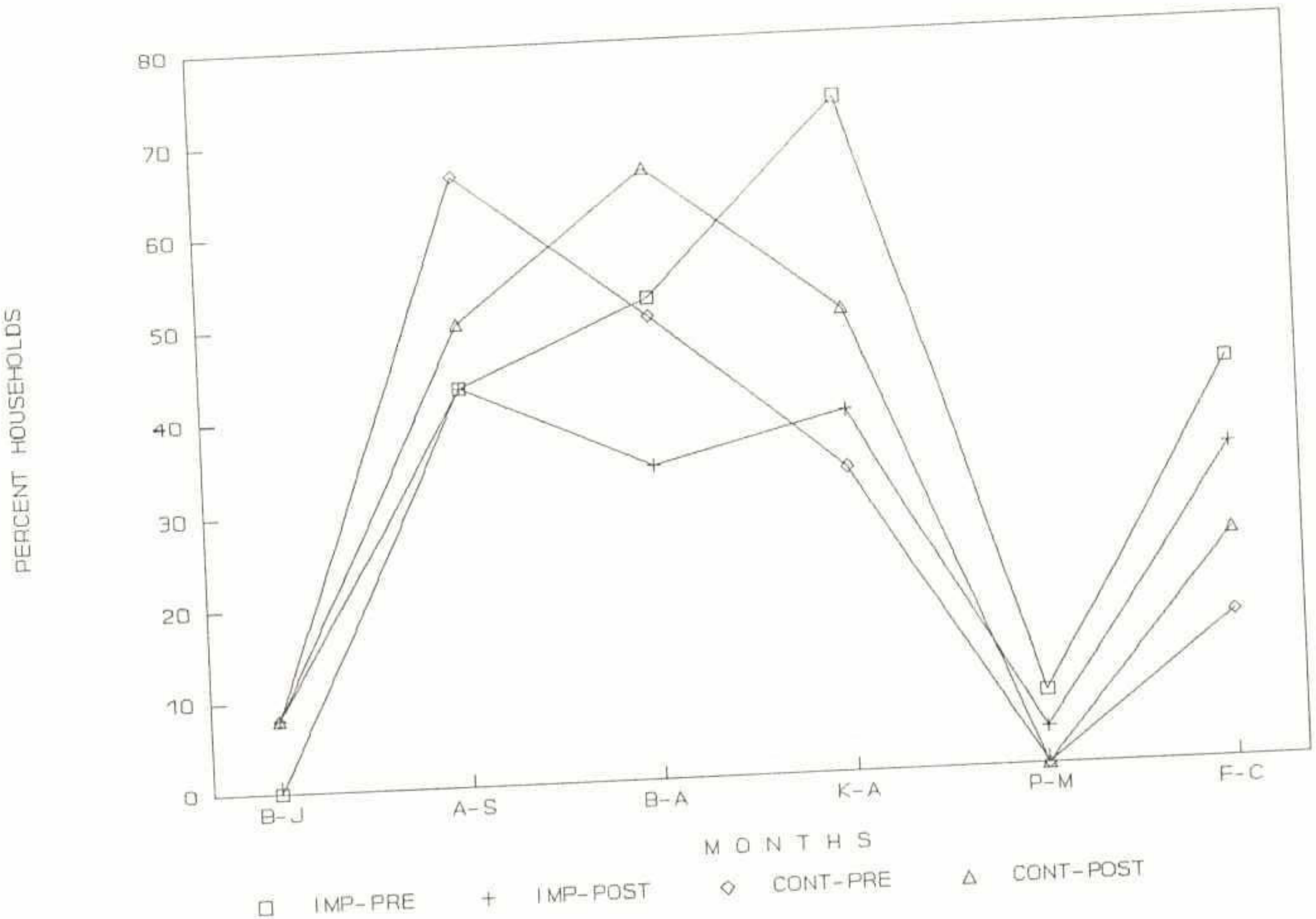
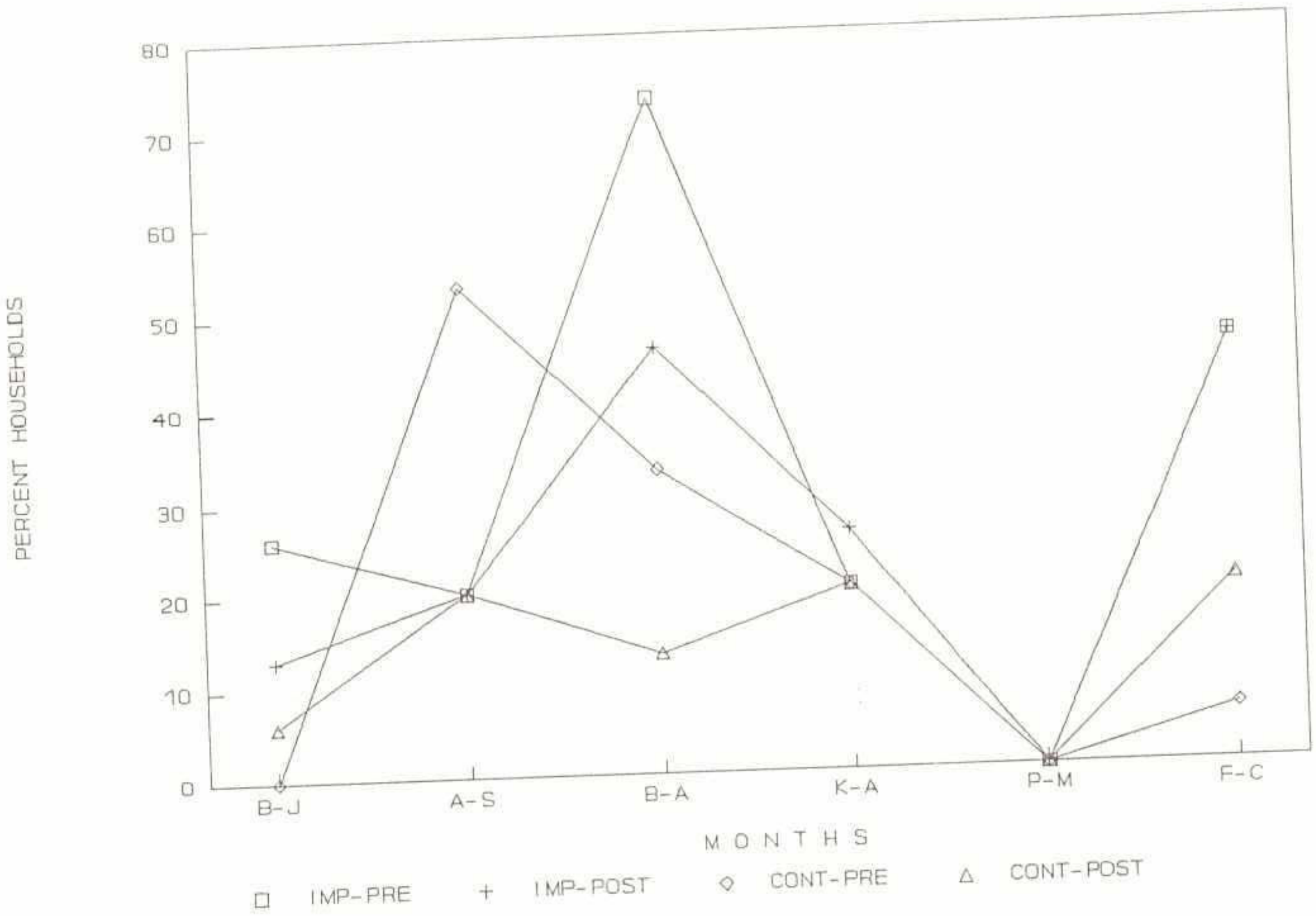


Figure 8.3 Starvation in Chalan Beel Polder D (Fishermen)



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8.4.11 Access to Safe Water

Table 8.15 shows the pattern of access to water by source and by type of use. The table clearly indicates that in the case of drinking water practically all households depend on safe sources (generally hand tube wells). In the case of cooking, too, one finds a heavy reliance on safe sources. Although in case of cleaning the use of safe water is much less, the proportion is far above that in most other PIE areas.

8.4.12 Problems of Water Quality and Associated Changes

Most women complained about changes in water quality in both impacted and control areas. But the complaints about diseases were very infrequent.

Gastro-enteric diseases are the most widespread among the various types mentioned by women and more so in the control area (67 cases in 98 households in the impacted compared to 51 cases in 60 households in the control).

Table 8.15 : Present Sources of Water by Type of Use in CBPD
(No. and percentage of total response by category of use by the type of household concerned)

Household type	Area	Cleaning		Cooking		Drinking	
		S	US	S	US	S	US
Farmer	Imp	21 (34)	40 (66)	50 (82)	11 (18)	58 (95)	3 (5)
	Cnt	10 (31)	22 (69)	28 (87)	4 (12)	32 (100)	-
Labourer	Imp	7 (32)	15 (68)	21 (95)	1 (4)	22 (100)	-
	Cnt	3 (23)	10 (77)	10 (77)	3 (23)	12 (92)	1 (8)
Fishermen	Imp	9 (60)	6 (40)	14 (93)	1 (7)	14 (93)	1 (7)
	Cnt	6 (40)	9 (60)	12 (80)	3 (20)	15 (100)	-
ALL	Imp	37 (38)	61 (62)	85 (87)	13 (13)	94 (96)	4 (4)
	Cnt	19 (32)	41 (68)	50 (83)	10 (17)	59 (98)	1 (2)

Source : FAP 12 PIE Household Survey

Note : Figures in parentheses indicate percentages of total number of responses by category of household

8.5 PROBLEMS FACED BY WOMEN DURING FLOODS

Women face many problems during floods. Lack of dry space and toilet facilities create grave difficulties for them (Table 8.16). Other major problems include those of drinking water and cooking and food availability. Quite surprisingly, the magnitude of the problems appear to be less severe in the control area. It may quite well be that the women in the impacted area feel the problems to be more severe as they are psychologically less prepared for such phenomena in the protected areas compared to those in the control.

Table 8.16 : Problems Faced by Women During Floods in CBPD
(Number and % of respondents - all groups)

Type of problem	Impacted	Control
Dry space	20 (20)	4 (7)
Drinking water	29 (30)	14 (23)
Toilet	40 (41)	8 (13)
Cooking	20 (20)	2 (3)
Food availability	12 (12)	3 (5)
Movement	1 (1)	-
Homelessness	1 (1)	1 (2)
No problem	1 (1)	-

Source : FAP 12 PIE Household Survey

Note : Figures in parentheses indicate percentages of total number of respondents. Some respondents have given more than answer.

9 SOCIO-ECONOMIC IMPACTS (Chalan Beel)

9.1 BACKGROUND

The project area was sparsely populated with a density of 579 persons per sq. km in 1978 (Feasibility Report,1979), which was lower than the national average population density. Land was highly unequally distributed and about a half of the rural households were agricultural labour households owning very little or no land at all. According to the Feasibility Report prepared in 1979 small farms and medium farms together constituted about 85 percent of farm households but between them owned only 42 percent of farm area. On the other hand, 15 percent of farm households had large farms and owned 58 percent of the farm area. Average farm size was 1.36 ha with a high degree of land fragmentation. About 70 percent of farm households were owner cultivators, while 27 percent were owner-cum-tenant (25 per cent) and pure tenant (2 per cent). Only 3 percent of farm households had non-farm incomes. Khaikhalashi was the dominant form of land mortgaging in the project area.

Farming and fishing were the major occupations, but cultivation of betel leaves (pan) was an important specialised farming activity in Mohanpur Upazila (which is entirely within Polder D). The incidence of seasonal outmigration of labour from the project area was high, but in some cases, especially in the betel leaf growing areas there was seasonal in-migration as well.

Social and physical infrastructure such as schools, madrashas, hospitals, roads and the transport system was well developed. The dominant form of transport was ox-carts in the dry season and boats in the monsoon. There were very few social organizations such as formal or informal cooperatives, landless groups, youth clubs, or fishermen's societies. Village societies (Samaj) used to play important roles in litigation, conflict resolution and social festivals.

9.2 OBJECTIVE OF THE PROJECT

The project was planned to provide flood control and drainage and limited irrigation to increase crop production, and might also increase employment opportunities. There was no explicit objective for improving social and institutional infrastructures and services, except that the Project Proforma (Planning Commission, 1989) mentioned in broad terms the 'promotion of self reliance' as an expected contribution of the Project. There were no explicit socio-economic objectives or any distributional targets for the Project area.

9.3 DEMOGRAPHIC CHARACTERISTICS

The demographic characteristics of the project area are shown in Table 9.1. The average family size in the impacted villages was slightly higher than in the control villages, except for fishermen households. As elsewhere, labour household family size in both the impacted and control villages was slightly smaller than other categories of households. The farming and labour households had a higher sex ratio (number of males per 100 females) in control areas than in the impacted areas, whereas the reverse was true for the fishermen and other household categories (differences which are unlikely to reflect any project effect). The different household categories in the impacted villages had generally higher dependency ratios than in the control villages.

Table 9.1 Demographic Characteristics of the Households in Chalan Beel Polder D.

Indicators	Farmer		Labourer		Fishermen		Others	
	Imp	Cont	Imp	Cont	Imp	Cont	Imp	Cont
Family Size (no.)	6.4	5.7	4.8	3.9	5.4	6.9	5.6	3.6
Sex ratio (male/female)	100	110	110	114	113	81	131	123
Dependency ratio	4.2	3.6	3.5	2.9	3.2	3.5	2.4	2.2
% literate hh head	69	55	26	8	53	73	65	78
% children attending school								
- Boys	86	79	66	50	42	100	89	93
- Girls	76	58	26	57	24	95	85	74

Source : FAP 12 PIE Household Survey, 1991

There is no systematic pattern in the level of literacy of the household heads between the impacted and the control villages. As regards school enrolment, the farmer and labour households had a higher proportion of school-age children attending school in impacted villages than in the control villages, but the opposite was true for the fishermen and the other household categories. Again there is a lack of any very obvious project related difference.

9.4 OCCUPATION AND EMPLOYMENT

9.4.1 Household Occupation

The average number of earners per household is in general less than two and the number of earners in farmer and fishermen households was lower for impacted than control villages (Table 9.2). The table also shows that the households in the control villages had a higher degree of involvement in secondary occupations compared to the impacted area, except for labour households. Labouring households generally had few secondary occupations compared with farming households in both impacted and control areas.

Table 9.2 Occupations of the Households in Chalan Beel Polder D.

Indicators	Farmer		Labourer		Fishermen		Others	
	Imp	Cont	Imp	Cont	Imp	Cont	Imp	Cont
Av. no. of earners	1.53	1.57	1.37	1.33	1.71	2.00	2.36	1.61
% hh heads with 2nd occup.	48	53	28	8	14	27	36	55
Incidence of different primary occup.[a]	6(3)	3(3)	3(5)	5(16)	3(12)	7(23)	9(27)	9(21)
Incidence of secondary occup.[b]	76(41)	47(50)	16(25)	4(13)	3(12)	11(37)	20(61)	12(41)

[a] Figures in parentheses are percentages of earners who are not involved in the major source of income.
[b] Figures in parentheses are percentages of earners who have a secondary occupation.

Source : FAP 12 PIE Household Survey, 1991

9.4.2 Occupational Changes

In Chalan Beel Polder D, there has not been any perceptible change in occupation of the main earners since project completion (Table 9.3). When the occupations of all earners are considered, there appears to be slightly more occupational mobility in the project areas, compared to the control areas, although the magnitude is not large (Table 9.4). A calculation shows that the ratio of percentages of earners changing main occupation since project completion was 8:4 for project:control areas.

Table 9.3 Main Earners' Main Occupation before and after the Project, Chalan Beel

Occupation	Impacted				Control	
	Protected		Unprotected			
	Pre	Post	Pre	Post	Pre	Post
No households	154		14		84	
Cultivator (%)	70	71	79	77	76	76
Agri. Labour (%)	27	27	14	14	23	24
Fisherman (%)	0	0	0	0	0	0
Transport (%)	1	1	0	0	0	0
Trade (%)	0	0	0	0	0	0
Salaried service (%)	0	0	0	0	0	0
Nonfarm labour (%)	1	1	7	7	0	0
Non-earning (%)	1	0	0	0	0	0

Source : FAP 12 PIE Household Survey, 1991

Table 9.4 Primary and Secondary Occupations of All Earners Before and After the Project (percentage earners)

Occupation	Protected		Unprotected		Control	
	Before	After	Before	After	Before	After
Cultivator	50	53	64	59	55	54
Agri. Labour	24	24	16	19	27	27
Fishermen	1	1				
Transport	1	1			2	2
Trade	9	10			11	11
Salaried Service	3	2		4	1	2
Non-farm Labour	7	9	12	11	1	3
Non-Earning	5	0	8	7	3	0
Total	311	322	25	27	164	177

Source: FAP 12 PIE Household Surveys

The RRA insights revealed that the embankment and the internal village roads connected with it have improved transport and communication facilities, which have helped in occupational diversification. For example, poorer households have now taken up secondary occupations such as pulling rickshaw vans, timber business, bamboo works, supplying bamboo poles and strips to betel-leaf plantations (pan baraj) and fuel wood to brick fields. The RRA findings also revealed that the improvements in road communication provided by the embankment and network of village roads facilitate government and non-government development activities such as those of BRDB (Mahila Samabay Samity (MSS) and Bityaheen Samabaya Samity (BSS) under the north-west Rural Development Programme, Christian Commission for Development in Bangladesh (CCDB) and Grameen Bank; these mostly aim to create income earning opportunities for women.

The PIE survey shows that there has been a reduction in the number of boatmen both in the impacted and control areas since the completion of the project. Chapter 6 showed a gradual decline in the number of part- time and full- time fishermen engaged in open water capture fisheries since the project, but the project did not make any institutional arrangement to compensate these affected people for such losses.

9.4.3 Employment Changes

The major sources of direct employment created by the Project were the earth work in construction, repair and maintenance of the embankment and the construction of the sluice gates and irrigation inlets. The poor households (both cultivators and non-cultivators) and the petty construction and labour contractors within and adjacent to the project benefited from this increased employment.

There has been at best a moderate increase in paddy production due to the Project in the impacted area compared to that in the control, hence there was very little additional crop sector employment in the impacted over those in the control area villages. Whilst it has not been possible to arrive at an estimate of crop sector employment per unit of land, agricultural labour household data provided some insights on their employment both within and outside the project. For example, Table 9.5 shows agricultural labour households on average obtained 222 man-days of work in the impacted villages and 225 man-days of work in the control villages. Thus there appears to be no difference in labour household employment between the impacted and the control area (note that such comparison is complicated because a part of the project labour household employment (8 percent) comes from outside the project while a part of control area labour household employment (13 percent) comes from the project area). Neither is there any difference in the monthly distribution of employment between the impacted and control areas.

Although there are monthly variations in the number of days of employment by agricultural labourers, there is no significant variation in wage rates between months and between the impacted and the control areas. The RRA insights, however, revealed that the wages included both cash and kind payment; cash wages were in the range Tk. 10-20 and kind wage was universally fixed at 1.5 kg of rice per day per labourer both within and outside the project. But there was clear wage discrimination between local labour and migrant ethnic Shantal labour, the latter usually getting Tk. 5 less than the local labourers per day.

As regards seasonal migration of labour, the PIE survey did not show any notable difference in the pattern of migration between pre-project and post-project period or between the impacted area and the control area, except that a higher proportion of households reported migration in the Aman and Boro season in the control area (Table 9.6). This fits with the RRA finding that labour households in the project area take advantage of the time lag in

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the cropping schedules between different agro-ecological regions and thus migrated to late Boro regions for Boro harvest (and also migrated for Aus operations) after the Boro harvest in the project area.

Table 9.5 Level of employment and wage rates of agricultural labour household head by months, 1990-1991, Chalan Beel

Months	Days employed				Mean Wage rate (Tk/day)	
	Impacted		Control		Inside	Control
	Mean	% days project	Mean	% days project		
Baishakh	21	100	20	22	34	33
Jaistha	19	91	22	12	33	34
Asar	18	91	19	12	32	33
Sravan	20	88	18	13	32	33
Bhadra	16	93	16	12	30	32
Aswin	12	91	13	14	29	30
Kartik	12	94	16	14	30	31
Agrahayan	22	93	22	13	32	34
Poush	22	89	22	13	33	33
Magh	21	90	20	12	32	32
Falgoon	21	92	18	13	34	32
Chaitra	18	91	19	12	34	32
Monthly average	18.5	92	18.75	12.72	32.08	32.41
Total	222		225			

Source : FAP 12 PIE Household Survey, 1991.

Table 9.6 Seasonal Pattern of Migration of Labourers, Chalan Beel Polder D
(Percentage of households reporting migration)

	Impacted Area		Control Area	
	Pre-project	Post-Project	Pre-project	Post-Project
Aus	42	36		
Aman	25	29	33	33
Boro	17	21	16	16
Aus+Aman	17	14		
Aman+Boro			33	33
All Seasons			16	16
No. hh migrating	12	14	5	6

Source : FAP 12 PIE Household Survey, 1991

9.5 INCOME DISTRIBUTION

As regards income distribution, the households in the impacted villages had 15 per cent higher income per household, and 13 per cent higher income per earner than the corresponding incomes in the control villages, but there was no difference in income per person (Table 9.7). Hence any marginally higher incomes in the Project are absorbed by the higher number of dependents. The slightly higher income arose mainly because of the higher proportion of households in the Project area being in the larger landholding categories, which have higher incomes per person and per earner, rather than any Project impact. Average incomes were not uniform across different landholding categories, larger landholding households showing higher incomes than the households in the smaller landholding categorise. Table 9.7 also shows that the households in the lowest two landholding categories (those upto 0.4 ha) had clearly higher average incomes in the control area than in the impacted areas, whereas those above 0.4 ha of land had higher average income in the impacted than in the control areas. This implies that whatever benefits could be generated by the project, in terms of slightly higher incomes, clearly went to landowners, especially to larger landowners.

Table 9.7 Household Income by Landholding Category, Chalan Beel Polder D (Tk in 1990-91)

Landholding (decimals)	No. hh	Impacted			No. hh	Control		
		Tk/hh	Tk/person	Tk/earner		Tk/hh	Tk/person	Tk/earner
≤ 20d	52	13076	2869	9189	26	13303	3391	11529
21-100d	41	16775	3155	12505	23	21693	4577	15119
101-250d	36	26258	4183	18178	23	23733	4135	16541
251-500d	20	39892	5018	20458	11	38413	5091	14570
501-750d	14	54475	6809	28246	0	-	-	-
+750d	5	95849	11689	39937	1	83536	9282	41768
All hh	168	25909	4383	16806	84	22580	4360	14935

Source : FAP 12 PIE Household Survey, 1991

However, a further disaggregation shows that the farming households in the Project appeared to be worse off than their counterparts in the control area, the former getting 19 per cent less income than the latter. This is not surprising given the frequent problems of cuts and breaches in the Project and hence great uncertainty and fluctuations in agricultural production. As a matter of fact, Chalan Beel Polder D is the one PIE project where there is no evidence that the project reduced environmental variability faced by the farmers at least in a large part of the area.

Not surprisingly in the sample households farming forms the main source of income, with the smallest landholding category forming a distinct labouring class (Table 9.8). In both Project and Control areas the proportion of income accruing from cultivation increases with landholding size. The only differences in income sources are the relative importance of business and labouring in the control area and of salaries and crafts in the project area (none of which are significant).

Table 9.8 Source of Household Income by Landholding Class, Chalan Beel

a) Impacted area

Landholding (decimals)	No. hh	Percentage of income from:										
		Culti-vation	Trees	Home-stead	Live-stock	Sala-ries	Busi-ness	Rents	Crafts	Fish-ing	Trans-port	Wage labour
< 20d	52	7	6	1	1	3	1	0	1	2	1	74
21-100d	41	40	10	2	9	3	0	0	16	2	2	16
101-250d	36	54	10	4	3	6	1	4	12	3	0	2
251-500d	20	62	8	1	6	7	0	2	11	2	0	0
501-750d	14	72	10	3	4	2	0	7	0	2	0	0
+750d	5	73	5	1	2	1	6	6	3	3	0	0
All hh	168	51	9	2	4	4	1	3	8	2	1	15

b) Control area

Landholding (decimals)	No. hh	Percentage of income from:										
		Culti-vation	Trees	Home-stead	Live-stock	Sala-ries	Busi-ness	Rents	Crafts	Fish-ing	Trans-port	Wage labour
< 20d	26	13	5	2	3	3	0	0	8	2	0	64
21-100d	23	47	6	1	4	3	0	0	10	2	1	24
101-250d	23	50	12	2	9	0	11	1	6	3	3	4
251-500d	11	67	13	1	1	0	9	3	2	1	0	3
501-750d	0	-	-	-	-	-	-	-	-	-	-	-
+750d	1	93	6	0	1	0	0	0	0	0	0	0
All hh	84	48	9	1	5	1	5	1	6	2	1	20

Source : FAP-12 PIE Household Survey, 1991

One conspicuous source of unequal income distribution has been induced by the BWDB through the construction of pucca irrigation inlets. Local influential people have been using these state-built structures along the Atrai river to operate their private LLP's and then sell irrigation water to earn monopoly profits (section 4.3.2). There is no institutional arrangement for taxing these monopolists or checking their power.

9.6 LAND HOLDINGS AND LAND ACQUISITION

9.6.1 Land Holdings

The PIE survey data show that similar percentages of households increased or decreased their holding in the impacted and the control areas since project completion

(Table 9.9). During the post-project period (i.e. 1986 onward) more land was purchased than sold by the households in the impacted area, whereas the opposite was true for the control area (Table 9.10). Overall there were virtually no significant changes in holding size in the control area, but inside the project a few households have expanded their holdings notably while others have dropped a category.

Table 9.9 Number of Households Experiencing a Change in Landholding since the Project, Chalan Beel Polder D.

Type of Change	Impacted		Control	Total
	Protected	Unprotected		
Increase	29 (18.8)	3 (21.4)	16 (19.0)	48 (19.0)
No Change	97 (63.0)	10 (71.4)	52 (61.9)	159 (63.1)
Decrease	28 (18.2)	1 (7.1)	16 (19.0)	45 (17.9)
Total	154 (61.1)	14 (5.6)	84 (33.3)	252 (100.0)

Source : FAP 12 PIE Household Surveys.

Note : Percentages in parenthesis.

Table 9.10 Amount of Land Purchased and Sold (dec), Chalan Beel

Year	Protected		Impacted, unprotected		Control	
	Purchased	Sold	Purchased	Sold	Purchased	Sold
1986	57	17	-	-	53	33
1987	73	130	-	-	41	5
1988	71	147	-	-	8	32
1989	132	124	33	-	21	82
1990	257	45	-	-	6	82
1991	3	70	-	-	-	-

Source : FAP 12 PIE Household Survey, 1991

Table 9.11 suggests that land prices in the impacted unprotected area may have increased less (possibly because of adverse project impacts on flooding), while in general land prices in the protected area have risen more than in the control area. However, the absolute level of land prices in 1991 was not reported to be higher in general in the project area, suggesting that there may have been a catching up effect, but that the returns expected by farmers are not higher in the project.

Table 9.11 Land Price (Tk/decimal) in Chalan Beel

Irrigation/ Period	Protected			Unprotected			Control		
Irrigated	H	M	L	H	M	L	H	M	L
Pre-project	302	482	277	500	300	300	737	356	332
Post-project	616	839	548	590	500	500	1280	655	620
% Change	+104	+74	+98	+18	+67	+67	+74	+84	+87
Non-Irrigated									
Pre-project	525	309	356	290	108	104	567	309	295
Post-project	1018	538	648	800	425	212	985	520	525
% Change	+94	+74	+82	+76	+94	+104	+74	+68	+78

Source : FAP 12 Community Survey.

Note : H=Highland; M=Medium highland; L=Lowland

9.6.2 Land Acquisition

Land had to be acquired for the construction of the embankment, and for drainage and irrigation inlets, and this appeared to be a source of discontent in FCD/I projects. In Chalan Beel such land was acquired from only 9 percent of households and average land area acquired per household was 18 decimals, almost all of which constituted agricultural land (Table 9.12).

Table 9.12 Incidence of Land Acquisition, Chalan Beel

Category	Land Type		Total
	Homestead	Agricultural	
No. of households	2	13	15
% of household affected	1%	8%	9%
Total area acquired (dec.)	3	275	278
Mean per HH with land acquired (dec.)	1.5	21.15	18.33

Source : FAP 12 PIE Household Surveys.

The payment of compensation was not very satisfactory in the sense that 3 out of 18 cases were not at all compensated, and in 7 out of 15 cases where compensation was paid the recipient had to pay a bribe, which constituted about 6 percent of the compensation value per decimal acquired (Table 9.13). However, bribes for compensation appeared to be less necessary in this project than the other PIE projects. What is more intriguing is the fact that the average time taken to realize compensation was longer (15 months) for the cases paying bribes than for those who reported not paying bribes (9 months). No doubt, the average compensation values reported (Tk. 135 per decimal without bribe and Tk. 263 per decimal with bribe) acre were much lower than the average prices of land quoted in Table 9.11.

Table 9.13 Payment of Compensation for Acquired Land, Chalan Beel

Category	No. of Cases	Mean Area (dec) of the plots acquired	Total Area acquired (dec.)	Mean Tk/dec compensated	Mean months for compensation	Mean Bribe Tk/dec
Not compensated	3	5	15	0	0	0
Compensated no bribe	8	14.9	119	135	8.75	0
Compensated after bribe	7	19.9	139	263	14.85	15.17
All cases	18	15.2	273	197	9.7	7.7

Source : PIE Survey.

9.7 INVESTMENT AND QUALITY OF LIFE

9.7.1 Non-land Assets

In the Chalan Beel area (both project and control areas), earth walled houses are very common; since these are very vulnerable to flood damages requiring major repairs (Table 9.14) this implies that flooding of buildings is relatively rare (as is confirmed by data in Section 9.8). The table also shows that a slightly higher proportion of households in the impacted areas made some investments in the form of major repair of damaged houses than in the control areas, but this appears to be a response to flood damage.

Table 9.14 Percentage of Households with different House Types, Chalan Beel Polder D

Construction Type (Main room)	Impacted		Control
	Protected	Unprotected	
Pucca wall	2	0	2
CI Wall and roof	0	0	1
Earth wall/Tile roof	71	64	70
Earth wall/Thatched roof	16	29	21
Thatched wall/Tile roof	2	0	1
Thatched wall and roof	5	7	4
Condition of Main House			
Good	18	36	17
Fair	49	21	57
Bad	33	43	26
Invested in New Construction since Project			
Major repair	36	14	25
New Room	12	14	13
Both	1	0	0
None	52	71	62

Source : FAP 12 PIE Household Surveys 1991.

Although the number of drinking water hand tubewells and sanitary toilets increased in both the protected and control villages, there was no perceptible difference in water and sanitation facilities between the impacted areas and the control areas. As regards ownership of other non-land assets, Table 9.15 shows that the farmer households in the impacted areas had clearly more assets such as ploughs, fishing nets, country boats, bicycles and irrigation equipment (HTW/MOSTI), than those in the control areas. However, boats for example are not widely owned in either area implying that deep flooding was not regular in pre-project conditions. This can easily be verified from Chapter 2 on Engineering and Hydrology.

Table 9.15 Incidence of Ownership of Selected Non-land Assets and Tools (% of households owning), Chalan Beel.

Type	Farmer		Labourer		Fishermen		Others	
	Imp.	Cont.	Imp.	Cont.	Imp.	Cont.	Imp.	Cont.
Plough	67	55	-	-	-	-	21	28
Fish Net	35	22	7	8	93	-	29	94
Boat	11	2	-	-	71	-	21	50
Bicycle	38	32	-	-	-	-	36	78
HTW/MOSTI	17	13	-	-	-	-	14	11

Source : FAP 12 PIE Household Surveys

9.7.2 Credit

The PIE survey shows that 36 per cent of cultivators and 12 per cent of non-cultivators in the protected villages took loans, compared with 38 and 33 per cent respectively in the control area. The average loan per cultivator borrower in the impacted villages was 88 per cent more than in the control villages (Table 9.16). Moreover, cultivator borrowers in the impacted villages used a substantially higher proportion of loans for farming purposes (cultivation and livestock) than those in the control villages. In the unprotected impacted areas farmers took much less credit which may reflect the risks to agriculture there.

Table 9.16 Credit Use During 1990-91, Chalan Beel Polder D

Indicators	Protected		Unprotected		Control	
	Farmer	Non-cultivator	Farmer	Non-cultivator	Farmer	Non-cultivator
No. hh	110	42	10	4	60	24
% hh receiving loan	36	12	20	25	38	33
Mean loan (Tk) (overall hh)	3878	157	700	400	2063	350
Percentage use of loans						
Cultivation	36	0	50	0	26	0
Livestock	8	0	0	0	4	4
House repair	5	0	0	0	4	13
Necessities	48	100	50	100	52	70
Social function	3	0	0	0	13	13

Source: PIE surveys

9.8 FLOOD IMPACTS

9.8.1 Incidence of Floods

The primary objective of the project was to protect the area from external flooding. The PIE survey shows that 95 per cent of respondents in the community surveys reported the occurrence of floods in the post-project period as against 77 per cent reporting floods every year and 18 per cent reporting floods in some years in the pre-project situation (Table 9.17), whereas the incidence of floods in the control area before and after the project appears to have been lower. Hence the project appears to have done little to alter the incidence of flooding in the sample villages. It is not surprising that a smaller percentage of Project inhabitants reported benefits from flood protection than in any other project. Chalan Beel Polder D is the PIE project which experiences floods almost every year due to natural breaches or public cuts along the Shib river leading to inundation within the project area. The RRA findings revealed a commonly cited fear of annual cuts of the embankment by outsiders near Tengraghata. Such organized public cuts cause a sudden on-rush of water within Polder D and lead to a chain of cuts of the major roads and village roads further down the polder. It finally induces the project insiders to cut the embankment in places such as Madhupur, Mansinhapur and Birkaya along the Fakirni river in order to remove drainage congestion. In the 1988 flood, the control area of the project suffered very little household flooding (it is of course somewhat less flood prone than the project area), and even the project area suffered a low incidence of homestead flooding. Given that agricultural flooding seemed common, it appears that homesteads are well adjusted (elevated) to the expected range of floods.

Table 9.17 Incidence of Floods (no. of mouzas affected) before and after the Project, Chalan Beel Polder D

Incidence	Protected	Unprotected	Control
Pre-Project			
Every year	17(77)	-	2(50)
Some years	4(18)	-	-
Rare	1(5)	2(100)	2(50)
Post-Project			
Flood	21(95)	2(100)	2(67)
No flood	1(5)	-	1(33)
Av.no. of flood years	2.3	4.0	2.0

Source : FAP 12 Community Surveys.

Note: Figures in parenthesis indicate percentage of total number of response.

9.8.2 Crop Damages in 1987 and 1988 Floods

The PIE survey, BWDB flood damage reports, and MPO (1991) all show that the embankment failed to protect the project area from the 1987 and 1988 floods. Not only that, the crop damages caused by these two floods appear to have been significantly more in the impacted areas than in the control areas (Table 9.18). This is quite likely given the fact that the project suffered breaches and cuts leading to sudden inundation.

Table 9.18 Percentage of Normal Yields Achieved in Chalan Beel Polder D During Flood Years

Crops	1987			1988		
	Protected	Unprotected	Control	Protected	Unprotected	Control
B. Aman	22	-	51	35	-	48
LT Aman	25	25	51	40	25	47
HYV Aman	30	-	58	35	-	45
B. Aus	27	-	56	39	-	50
HYV Aus	62	50	68	91	50	52
Jute	25	-	65	30	-	59

Source : FAP 12 Community Surveys

9.8.3 Other Household Flood Damages

The most damaging homestead flooding occurred in 1988 for both impacted and control areas, but a relatively low percentage of households (25 per cent and 8 per cent respectively in protected and control areas) were affected, and there has been some homestead flooding in 1989 and 1990. Average depth of flooding in the homestead did not differ between the protected and control areas, but the mean duration of floods in the control areas was double the duration in the protected area. However, mean non-crop damages per affected household were substantially (26 per cent in 1988) higher in the protected areas than in the control areas (Table 9.19). This indicates that there is a lack of awareness of flood risk or of adjustment mechanisms for reducing flood damages to homesteads inside the project. Further investigation of this problem might be warranted.

9.9 LOCAL PARTICIPATION, OPINIONS AND SOCIAL CONFLICTS

There was virtually no consultation with local people at the planning or implementation stage, meaning that BWDB missed the benefits of local knowledge with respect to soil type, topography, flood incidence and hydrology. The RRA insights revealed that the project failed to involve local people in the routine operation and maintenance of regulators or irrigation inlets. There are no local committees for these structures and these are operated at the will of local influential persons. It is not surprising that the perceptions of Project inhabitants reported in the PIE are that the project was initiated by the local influential people and the members of the Union and/or Upazila Parishad. In the protected villages 37 per cent of farmer households and 31 per cent of non-cultivators and 90 per cent farmer and 75 per cent non-cultivator in the adjacent nonprotected areas expressed doubts about the necessity of the project. The doubts about the project were so strong that a quite high proportion of doubting households attempted to prevent the project construction by launching petitions and even using force (Table 9.20). Given the apparent adverse external impacts of the project, these fears were well founded.

Table 9.19 Recent Homestead Flooding, Chalan Beel Polder D.

a) Characteristics of last flood of homestead

Flood year	Indicator	Protected	Unprotected	Control
1988	No. of hh flooded	38	4	7
	Mean depth (ft.)	2	2	2
	Mean duration (days)	8	19	16
1989	No. of hh flooded	2	0	1
	Mean depth (ft.)	2		1
	Mean duration (days)	4		16
1990	No. of hh flooded	2	0	0
	Mean depth (ft.)	2		
	Mean duration (days)	17		

b) Mean Non-crop Damage per Affected Household (Tk).

Year	Protected	Unprotected	Control
1988	2617	2400	2080
1989	3000	-	600
1990	2250	-	-
Percentage of flooded households reporting non-crop damage			
1988	76	75	71
1989	50	-	100
1990	100	-	-

Source : FAP 12 PIE Household Survey.

The project has clearly given rise to conflicts of interests between farmers and fishermen about the timing of draining out water from the beels, and between project insiders and outsiders over organizing/resisting public cuts. The RRA also highlighted the fact that the project people in the most flood prone villages showed a reasonably cooperative attitude towards the protection and maintenance of the embankment bys voluntarily watching vulnerable sections of embankment or dropping sand bags at the sections which were breaching during the peak floods. The farmers also appeared to have arranged provision of temporary irrigation inlets for themselves by cutting the embankment and then closing it well ahead of the monsoon season. This demonstrated that the beneficiaries can organize themselves to operate and maintain the structures efficiently, especially if they perceive the potential benefits of such actions.

Relatively few households in the impacted unprotected area reported any benefits except for some improvement in communications; however 50 per cent reported that crops were saved from floods and 27 per cent reported that it protected houses from floods (but 70 per cent reported improved communications). A wider range of problems were reported to be suffered by substantial numbers of households (both farming and non-cultivating). The most commonly reported disbenefits were: problems of waterlogging (57 per cent of households), public cuts (51 per cent of households), damage to embankment (47 per cent of households), loss of open water capture fisheries (35 per cent of households) and decline in boat transport (18 per cent of households). As was to be expected similar disbenefits were also reported by people living adjacent to but outside the Project.

Table 9.20 Conflicts over Project Implementation, Chalan Beel

Whether households doubted usefulness of project and measures taken	Protected		Unprotected	
	Farmer	Non-cultivator	Farmer	Non-cultivator
% of all households with doubts about project	37	31	90	75
No. of households with doubts	41	13	9	3
% doubting households attempting to prevent project	19		33	
Measures taken (no. households)				
Petitioned BWDB	5		0	
Petitioned DC	7		0	
Protested to local admin.	3		1	
Used force	5		3	

Source : FAP 12 PIE Household Survey.

As in other PIE projects, there was wide agreement between quantitative and qualitative estimates of the distribution of benefits/disbenefits and peoples' perceptions about who benefited or disbenefited most from the project. Large landowners, farmers, labourers and businessmen were regarded as the main beneficiaries of the project, while fishermen, and boatmen were regarded as the main disbenefited groups. However, the percentages of households reporting that the groups benefited or disbenefited were generally less than in other PIE projects, suggesting that impacts were less clear cut. Modest minorities even reported that farmers and labourers disbenefited. The coherence between actual impacts of the project and people's benefits and perceptions about the project implies that there should be provision for consultation with the potential beneficiaries and disbeneficiaries and for accommodating their views into the project design. Where it is not possible for technical or financial reasons to follow all the wishes of local people or where disbenefits are inevitable then appropriate compensating or mitigatory measures should be taken.

10 ECONOMIC ASPECTS

10.1 INTRODUCTION

An attempt is made in this chapter to carry out an economic post-evaluation of the Project, based on the impact on monsoon paddy (ie. Aus and Aman). Other crops have been ignored as it has been assumed that these have not been affected by the Project. This impression is also reinforced by the pre-PIE RRA as well as by subsequent PIE data, for example on Boro coverage and yields (see Chapter 4). The negative impact on fisheries has been estimated and valued, and taken into account explicitly. Other adverse impacts noted (e.g in the feasibility report as well as in the pre-PIE RRA) could not be taken into account, although these are mentioned in qualitative terms in the appropriate chapters particularly in Chapter 11 on Environmental Evaluation.

10.2 PROJECT COSTS

Financial and economic costs of the Project by year are shown in Table 10.1. The construction of the Project was initiated in 1981/82 and was completed in 1988/89. The feasibility report estimated Project costs at Tk 285 million, while the final (revised) PP quoted a figure of Tk 373.2 million. Financial and economic costs indicated are in 1991 prices.

The actual O&M figures are not very different from that in the revised PP (Tk 4.80 m instead of Tk 4.2 m), and forms 1.4 per cent of total capital costs. As a ratio, O&M expenditure appears to be lower here than in other projects (for example, O&M costs are 5.7 per cent and 5.1 per cent in Kamarjani, BRE).

Table 10.1 Financial and Economic Costs of Project, 1991 Prices (Taka, millions)

Year	Financial		Economic	
	Capital	O&M	Capital	O&M
1981-82	3.1		2.5	
1982-83	10.1		8.1	
1983-84	35.3		28.2	
1984-85	60.3		48.3	
1985-86	100.3		80.3	
1986-87	47.6		38.2	
1987-88	70.3		56.3	
1988-89	15.4		12.5	
1989-90		4.80		4.45

Source and Notes: Capital costs are based on revised PP (October, 1988). O & M figures are based on data received from BWDB Office, Rajshahi, and are averages of 1989-90 and 1990-91. The O & M costs are basically in FFW wheat, for which market prices of Tk 5300 and Tk 5500 were assumed for 1989-90 and 1990-91. Conversion factors for economic pricing are based on FPCO (1991). Financial costs shown exclude transfer payments such as land acquisition.

10.3 VALUE OF GROSS OUTPUT

Table 10.2 presents data on yields, value of output and of byproducts for the Aus and Aman crops, in the Project and Control areas. These are reproduced here from Chapter 4 on agricultural impacts. It will be observed that average aggregate yields in the two areas are very similar, there being no statisticaly significant difference between the two. Predictably, this results in a very small difference in the per hectare value of output. For byproducts, the picture is somewhat different, there being almost a Tk 1000 difference in value in favour of the Project area. This has arisen because of the greater concentration of local (T) Aman in the Project area (43 per cent of gross cropped area under monsoon paddy, compared to 13 per cent in the Control) and a lower concentration of HYV varieties which have a lower byproduct ratio and lower price. Gross benefits per ha arising out of the Project are thus estimated at Tk 1100.

Table 10.2 Gross Output Value and Gross Project Benefit

Crop	Project			Control		
	Yield MT/ha)	Output (Tk,Fin)	Byproduct (Tk)	Yield (MT/ha)	Output (Tk, Fin)	Byproduct (Tk)
B.Aman	1.6	131681.3	31948.8	0.92	27683.93	6716.736
T.Aman(L)	2.23	298541	121989.9	2.04	25025.95	10226.11
T.Aman(H)	3.8	64951.88	8595.6	3.11	89268.76	11813.65
Mixed		0	0	1.68	1055.069	0
T.Aus(L)	2.74	18498.29	5566.08	2.3	3881.94	1435.2
B.Aus	1.94	89392.87	34702.72	1.72	23500.19	9122.88
T.Aus(H)	3.47	47040.01	6225.18	3.05	31099.69	4115.67

Average Yield	2.12 (.175)	1.95 (.321)
Output(Tk/ha)		
Fin	10746	10601
Eco	10423	10282
Byproducts		
Fin	3455	2285
Eco	2833	1874

Gross Project Benefits per ha (Tk): 1100

Source: Based on PIE survey. Conversion factors for shadow pricing derived from FPCO(1991). Figures in brackets are confidence limits of yields at the 75 per cent level.

10.4 COST OF PRODUCTION AND TOTAL BENEFITS

Cost of production data (both financial and economic) by crops is presented in Table 10.3. The last row indicates the average per hectare costs (all crops), from where it will be seen that costs are higher in the control than in the Project area. In economic terms, control area costs are around Tk 900 higher per hectare, which when combined with the information on gross Project benefits, yields a net benefit of over Tk 2000 per hectare. Thus total Project benefits are estimated at Tk 89.45 million per annum. It needs to be clearly noted that these benefits have mainly arisen not from superior crop yields but from byproducts and lower costs of production.

Table 10.3 Costs of Production

Crop	Project Area (ha)	Tot Cost (Eco,Tk)	Tot Cost (Tk,Fin)	Control Area (ha)	Tot cost (eco)	Tot Cost (Fin)
B.Aman	19.2	61670.4	71116.8	7.02	28262.52	30698.46
T.Aman(L)	26.3	133183.2	140194.8	2.41	12652.5	13963.54
T.Aman(H)	2.9	21868.9	25003.51	4.87	37041.22	38380.47
Mixed		0	0	0.13	543.53	625.69
T.Aus(L)	1.2	9189.6	8623.56	0.3	1823.4	2418
B.Aus	8.6	36146.91	39618.48	2.55	11954.4	12801
T.Aus(H)	2.3	17573.59	17348.67	1.73	13374.63	14397.06
Cost/ha (Eco, Tk)	4622			5558		

Source: Based on PIE survey. 1991 prices are used, and conversion factors for shadow pricing are from FPCO (1991).

10.5 THE IMPACT ON FISHERIES

Attention to the potentially serious adverse impact on fisheries was drawn by the Project Feasibility Report (BWDB). Estimates of fish loss are also available from the PIE (see Chapter 6). The upper estimate is put at 2083 MT, with a value of Tk 55.41 million, while the lower estimate is placed at 1439 MT, valued at Tk 38.3 million (at 1991 economic prices). Of the PIE projects covered, fish losses in Chalan Beel were found to be amongst the highest. Thus per hectare fish loss in Chalan Beel (net benefited area) is .056 MT compared to .003 MT in Kurigram South, .029 MT in MDIP and .03 MT in Zilkar.

10.6 BENEFIT-COST ANALYSES

On the basis of data on Project costs, net benefits, fisheries losses and costs of production, a benefit-cost analysis was carried out.

Looking first at the difference between the project area and the control area in terms of agricultural benefits, the EIRR is estimated to be 26.4 per cent. However, if fisheries disbenefits are included along with agricultural benefits and using the lower estimate of fisheries losses, the Chalan Beel Polder D Project appears to be just viable, with an EIRR of 14.4 per cent. If the upper estimate of fisheries losses is used, the EIRR falls to around 8.5

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per cent, below the 12 per cent cut off point. On the basis of these estimates, the Project can at best be considered marginal. To reinforce this point, standard errors were calculated for average yields at the 75 per cent level. Thus for the impacted and control areas, estimated standard errors are .175 and .321 metric tons, so that the maximum yield difference between the two areas could be as high as .68 metric tons (as opposed to a difference of .17 metric tons), while the minimum difference is a-0.33. The corresponding EIRRs therefore, range from negative to 67 per cent. Under the circumstances, a firm conclusion about project viability is difficult to derive in this particular case, and reminds us of the similar results derived for Kurigram South.

The conclusion that the CBPD may be at most a marginal project is strengthened if we consider the fact (as discussed earlier in Chapter 4) that in the study year the control area suffered particularly heavily due to crop damages. If farmer's notions of average 'normal' yields are used the overall average yield differential goes against the impacted area. In such a situation the project will have a negative return and would at best have no economic benefit to distinguish it from the control area.

10.7 CONCLUSION

The Chalan Beel Polder D even at its best is a marginally viable project. While fisheries disbenefits have been substantial even the economic value of net agricultural benefit of the project remains questionable. As various earlier chapters have shown the main reason for this has been the continuing uncertainty regarding public cuts and breaches and the resulting sudden inundation.

Table 10.4 Post-project Economic Appraisal of CBPD
(All valuations are at 1991 prices)

Scenario	EIRR (%)	B-C Ratio	NPV (Taka million)
Agricultural benefits	26.4	2.24	234.8
Agricultural benefits + Fisheries disbenefits(L)	14.4	1.20	37.4
Agricultural benefits + Fisheries disbenefits(H)	8.5	0.73	-50.8

Source: Consultant's estimate based on FAP 12 PIE Household Survey and other data.

Note: L: low estimate; H: high estimate

Appendix to Chapter 10
Economic Appraisal of CBPD

Table A10.1 Cash Flows: Chalan Beel Project
(Constant economic values, 1991 prices, 00,000 Taka)

Year	Low Fisheries Losses	Agricultural Benefits	Capital Costs	O&M Costs	Total Costs	Net Economic Benefits
1981-82			25		25	-25
1982-83			81		81	-81
1983-84			282		282	-282
1984-85			483		483	-483
1985-86		0	803		803	-803
1986-87	-382.8	447.25	382		382	-317.55
1987-88	-382.8	670.875	563		563	-274.925
1988-89	-382.8	894.563428	125	0	125	386.763428
1989-90	-382.8	894.5	0	79.8	79.8	431.9
1990-91	-382.8	894.5	0	79.8	79.8	431.9
1991-92	-382.8	894.5		79.8	79.8	431.9
1992-93	-382.8	894.5		79.8	79.8	431.9
1993-94	-382.8	894.5		79.8	79.8	431.9
1994-95	-382.8	894.5		79.8	79.8	431.9
1995-96	-382.8	894.5		79.8	79.8	431.9
1996-97	-382.8	894.5		79.8	79.8	431.9
1997-98	-382.8	894.5		79.8	79.8	431.9
1998-99	-382.8	894.5		79.8	79.8	431.9
1999-2000	-382.8	894.5		79.8	79.8	431.9
2000-01	-382.8	894.5		79.8	79.8	431.9
2001-02	-382.8	894.5		79.8	79.8	431.9
2002-03	-382.8	894.5		79.8	79.8	431.9
2003-04	-382.8	894.5		79.8	79.8	431.9
2004-05	-382.8	894.5		79.8	79.8	431.9
2005-06	-382.8	894.5		79.8	79.8	431.9
2006-07	-382.8	894.5		79.8	79.8	431.9
2007-08	-382.8	894.5		79.8	79.8	431.9
2008-09	-382.8	894.5		79.8	79.8	431.9
2009-10	-382.8	894.5		79.8	79.8	431.9
2010-11	-382.8	894.5		79.8	79.8	431.9
2011-12	-382.8	894.5		79.8	79.8	431.9
2012-13	-382.8	894.5		79.8	79.8	431.9
2013-14	-382.8	894.5		79.8	79.8	431.9
2014-15	-382.8	894.5		79.8	79.8	431.9
2015-16	-382.8	894.5		79.8	79.8	431.9
2016-17	-382.8	894.5		79.8	79.8	431.9
2017-18	-382.8	894.5		79.8	79.8	431.9

EIRR	14.45
PVB @ 12%	2270.80
PVC @ 12%	2024.34
BC RATIO @ 12%	1.12
NPV @ 12%	246.46

Appendix to Chapter 10
Economic Appraisal of CBPD

Table A10.2 Cash Flows: Chalan Beel Project
(Constant economic values, 1991 prices, 00,000 Taka)

Year	High Fisheries Losses	Agricultural Benefits	Capital Costs	O&M Costs	Total Costs	Net Economic Benefits
1981-82			25		25	-25
1982-83			81		81	-81
1983-84			282		282	-282
1984-85			483		483	-483
1985-86		0	803		803	-803
1986-87	-554.1	447.25	382		382	-488.85
1987-88	-554.1	670.875	563		563	-446.225
1988-89	-554.1	894.563428	125	0	125	215.463428
1989-90	-554.1	894.5	0	79.8	79.8	260.6
1990-91	-554.1	894.5	0	79.8	79.8	260.6
1991-92	-554.1	894.5		79.8	79.8	260.6
1992-93	-554.1	894.5		79.8	79.8	260.6
1993-94	-554.1	894.5		79.8	79.8	260.6
1994-95	-554.1	894.5		79.8	79.8	260.6
1995-96	-554.1	894.5		79.8	79.8	260.6
1996-97	-554.1	894.5		79.8	79.8	260.6
1997-98	-554.1	894.5		79.8	79.8	260.6
1998-99	-554.1	894.5		79.8	79.8	260.6
1999-2000	-554.1	894.5		79.8	79.8	260.6
2000-01	-554.1	894.5		79.8	79.8	260.6
2001-02	-554.1	894.5		79.8	79.8	260.6
2002-03	-554.1	894.5		79.8	79.8	260.6
2003-04	-554.1	894.5		79.8	79.8	260.6
2004-05	-554.1	894.5		79.8	79.8	260.6
2005-06	-554.1	894.5		79.8	79.8	260.6
2006-07	-554.1	894.5		79.8	79.8	260.6
2007-08	-554.1	894.5		79.8	79.8	260.6
2008-09	-554.1	894.5		79.8	79.8	260.6
2009-10	-554.1	894.5		79.8	79.8	260.6
2010-11	-554.1	894.5		79.8	79.8	260.6
2011-12	-554.1	894.5		79.8	79.8	260.6
2012-13	-554.1	894.5		79.8	79.8	260.6
2013-14	-554.1	894.5		79.8	79.8	260.6
2014-15	-554.1	894.5		79.8	79.8	260.6
2015-16	-554.1	894.5		79.8	79.8	260.6
2016-17	-554.1	894.5		79.8	79.8	260.6
2017-18	-554.1	894.5		79.8	79.8	260.6

EIRR	7.97
PVB @ 12%	1387.74
PVC @ 12%	2024.34
BC RATIO @ 12%	0.69
NPV @ 12%	-636.61

Appendix to Chapter 10
Economic Appraisal of CBPD

Table A10.3 Cash Flows: Chalan Beel Project
(Constant economic values, 1991 prices, 00,000 Taka)

Year	High Fisheries Losses	High Agricultural Benefits	Capital Costs	O&M Costs	Total Costs	Net Economic Benefits
1981-82			25		25	-25
1982-83			81		81	-81
1983-84			28		282	-282
1984-85			483		483	-483
1985-86		0	803		803	-803
1986-87	-554.1	1690	382		382	753.9
1987-88	-554.1	2535	563		563	1417.9
1988-89	-554.1	3380	125	0	125	2700.9
1989-90	-554.1	3380	0	79.8	79.8	2746.1
1990-91	-554.1	3380	0	79.8	79.8	2746.1
1991-92	-554.1	3380		79.8	79.8	2746.1
1992-93	-554.1	3380		79.8	79.8	2746.1
1993-94	-554.1	3380		79.8	79.8	2746.1
1994-95	-554.1	3380		79.8	79.8	2746.1
1995-96	-554.1	3380		79.8	79.8	2746.1
1996-97	-554.1	3380		79.8	79.8	2746.1
1997-98	-554.1	3380		79.8	79.8	2746.1
1998-99	-554.1	3380		79.8	79.8	2746.1
1999-2000	-554.1	3380		79.8	79.8	2746.1
2000-01	-554.1	3380		79.8	79.8	2746.1
2001-02	-554.1	3380		79.8	79.8	2746.1
2002-03	-554.1	3380		79.8	79.8	2746.1
2003-04	-554.1	3380		79.8	79.8	2746.1
2004-05	-554.1	3380		79.8	79.8	2746.1
2005-06	-554.1	3380		79.8	79.8	2746.1
2006-07	-554.1	3380		79.8	79.8	2746.1
2007-08	-554.1	3380		79.8	79.8	2746.1
2008-09	-554.1	3380		79.8	79.8	2746.1
2009-10	-554.1	3380		79.8	79.8	2746.1
2010-11	-554.1	3380		79.8	79.8	2746.1
2011-12	-554.1	3380		79.8	79.8	2746.1
2012-13	-554.1	3380		79.8	79.8	2746.1
2013-14	-554.1	3380		79.8	79.8	2746.1
2014-15	-554.1	3380		79.8	79.8	2746.1
2015-16	-554.1	3380		79.8	79.8	2746.1
2016-17	-554.1	3380		79.8	79.8	2746.1
2017-18	-554.1	3380		79.8	79.8	2746.1

EIRR	60.10
PVB @ 12%	13180.64
PVC @ 12%	2024.34
BC RATIO @ 12%	6.51
NPV @ 12%	11156.30

11 ENVIRONMENTAL EVALUATION

11.1 PRE-PROJECT SITUATION

Chalan Beel D was the last of the four Chalan Beel polders to be completed and it was finished a good deal later than the others. Construction began in 1981 and the embankment and most major works were finished in 1985. 1991 is therefore the project's sixth monsoon season.

Two clarifications are needed regarding what this environmental evaluation aims to cover.

i. The Project included a substantial main and village road construction component which has in fact exceeded its original aims and has clearly achieved major positive socio-economic impacts in many parts of the area. This is excluded from the environmental evaluation, to allow the latter to distinguish the FCD elements of the Project.

ii. As discussed in Chapter 2, the Project suffered public and a few natural breaches in the embankments in 1986, 1987, 1989 and even a couple in the drought year of 1990, some of which remain open in 1991. It is essential that the evaluation assesses what has actually happened, rather than what was originally hoped would happen.

Chalan Beel D is one of the largest and most complex of the 17 projects studied by FAP 12. FAO (1988) shows it to comprise parts of three agroecological regions (AER) and agroecological subregions (AES), as shown in Figure 11.1 and Table 11.1. Figure 11.1 also shows the distribution of the soil associations.

This agroecological classification provides a broad picture of pre-project environmental conditions, especially when taken in conjunction with the pre-project flood-depths (Figure 11.2). The difficulty is that both Figures 11.1 and 11.2 are very generalised; on the ground, much of Chalan Beel D reveals obvious patterns of old river channels, levees forming low ridges, mid-slopes grading down into lower floodplain, with a seasonal or perennial beel often in the lowest parts (see AED B below). Unfortunately such patterns do not readily emerge at scales of 1:200,000.

Even so, bearing these detailed local patterns in mind, it is possible to recognise four basic agroecological divisions (AED) as follows (see Figure 11.2).

AED A - Dominantly Highland and Medium Highland in which flooding was rare to shallow in pre-project times, occurring chiefly on Atrai alluvial soils and Barind Tract (27 per cent of the Project Area).

AED B - Intermediate and rather variable areas mainly in Ganges alluvium in which Medium Highland and Highland ridges alternate with low-lying depressions, resulting in a complex range of flood conditions (53 per cent of the area).

Table 11.1: Chalan Beel D: Agroecological Divisions

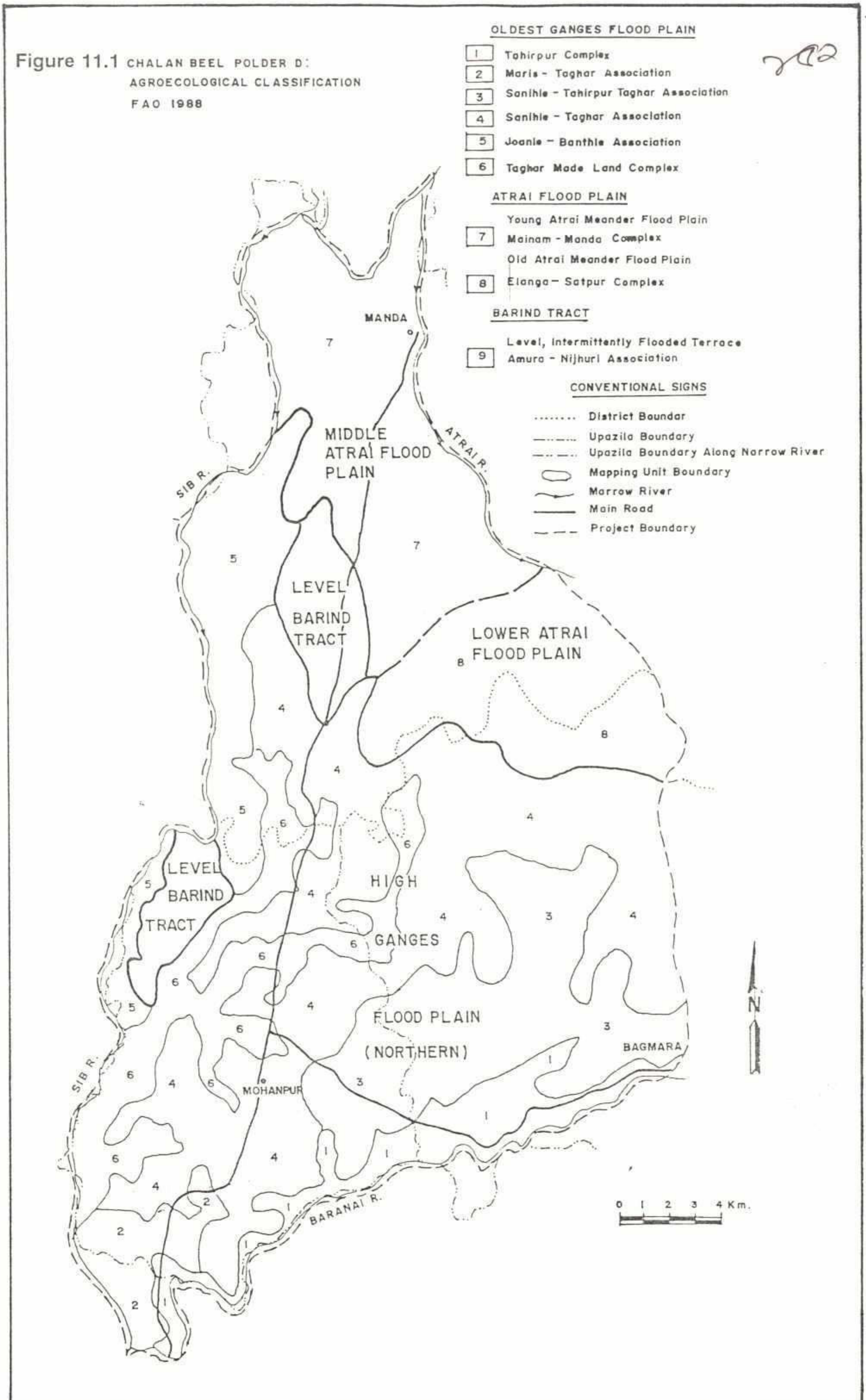
Agroecological Region	Agroecological Subregion	Soil Association	% of Area	Dominant Land Types*
11. HIGH GANGES RIVER FLOODPLAIN	116. NORTHERN HGRF	Gh 191	6	H
		Gh 192	3	MH
		Gh 202	13	ML-H-MH
		Gh 207	26	ML-MH-H
		Gh 209	8	L-ML
		GH 193	10	H
			66	
3. TISTA MEANDER FLOODPLAIN	3f. Middle Atrai Floodplain	Tm 213	14	H-MH
	3g. Lower Atrai Floodplain	Tm 214	11	ML-L-H
			25	
25. LEVEL BARIND TRACT	25a. Highland and Medium Highland	Bl 226	9	H
			9	
Total			100	

* All Land Types exceeding 15% of the Association, given in order of dominance.

Land Type		Flooding Depth (cm)
H -	Highland (including medium Highland I)	0 - 30
MH -	Medium Highland II	30 - 90
ML -	Medium Lowland	90 - 180
L -	Lowland	180 - 300

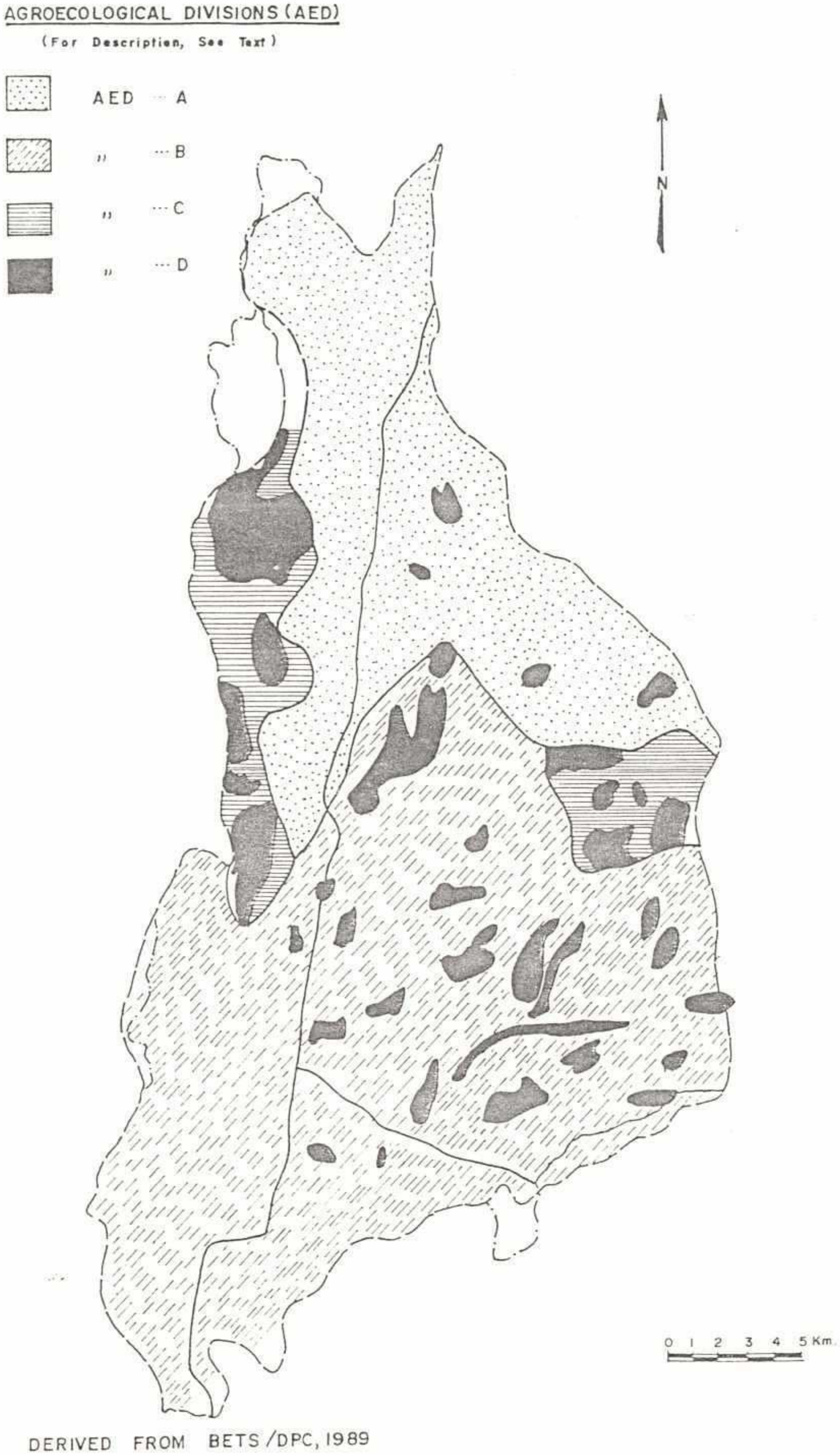
Source: FAO, 1988

Figure 11.1 CHALAN BEEL POLDER D: AGROECOLOGICAL CLASSIFICATION FAO 1988



Source : FAO, 1988

Figure 11.2 CHALAN BEEL POLDER D: AGROECOLOGICAL DIVISIONS



DERIVED FROM BETS/DPC, 1989

AED C - Large basins subject to deep flooding, usually more than 150 cm, surrounding the main beels in the north west and south east, on lower-lying Ganges and Atrai alluvium (9 per cent).

AED D - Perennial wetlands and waterbodies: some old river channels and the larger khals, but primarily the true perennial beels (11 per cent), such as Hilna, Monki, Uthrail and Katigram in the west and Maller, Joka, Jaypura and Haker in the east (note that a number of large beels occurred pre-project along the Sib river outside the present bund e.g. Manda, Chanditora, Jaonlal.)

AED A has mainly permeable, silty soils which pre-project were largely under aus and jute followed by early rabi crops, with sugar cane especially in the north. Late rabi drought and occasional serious floods near the Atrai were problems. Alternating paddy and rabi crops had caused severe deterioration in topsoil structure, inhibiting the latter. The area was prone to hydrological and seismic instability. The relatively dry climate was a disadvantage in all AEDs.

AED B suffered from droughty soil conditions on the low ridges while the basins were still prone to early drought but also to late and usually deep flooding, followed by delayed drainage. The silty ridge soils have lime at shallow depths, and grade down into fine-textured but still permeable basin soils. The diverse range of potential problems, depending on each year's climatic variations, clearly required as much flexibility of response as possible on the part of cultivators. Potentially valuable agricultural land on the ridges was being absorbed by the spread of settlement and industry. The main land use in the basins was B. Aman paddy. The permeable soils and relatively strong relief resulted in shallow watertables in much of the area, in which iron content was high.

AED C consists of large depressions which are otherwise similar in soil and other ecological characteristics to the lower lands of AED B. However, being larger and deeper, AED C depressions suffered deeper flooding and more intransigent drainage problems. During the monsoon, they merged with the beels which they typically surround, and fish became ecologically and socio-economically important. Land use was either B. Aman paddy or, in the lowest areas, seasonal grazing and fishing.

AED D accounted for a very substantial part of the Project Area, occupied by various forms of wetland. As mapped in Figure 11.2, the division essentially comprised essentially permanent wetlands. Pre-project it seems that these still retained some natural ecological qualities, in terms of fauna and flora, with fish in particular having considerable socio-economic importance. The fish communities, however, had been declining for some years, especially in the main western tract of AED D, due to the total closure of the Sib river just below its exit from the main Atrai River, at Baidypur Bazar. The local people originally built an earth barrier as early as 1959, which BWDB reinforced with a concrete structure in 1977/78. Fishing was the only major land use.

Four rivers surround the Chalan Beel D area: Sib, Atrai, Fakirni and Barnai. Before the Project, most flooding emanated from the Sib in the more elevated land to the west and moved south-eastward across the area. Even lands adjacent to the Fakirni and Barnai in the south east received most of their flooding from the north west (Sib). The natural flooding direction of the other rivers was over their opposing banks, following the regional physiographic trend.

11.2 PROJECT OBJECTIVES

No account was taken of environmental aspects in the various project preparation documents (Section 11.3), although they included a good deal of useful and relevant information relating to the environment. As with most of the FCD projects, and especially the larger ones, the need for a full Environmental Impact Assessment is in retrospect extremely evident. Project appraisal based on economic analysis largely ignored or dismissed a number of key issues that the holistic perspective of environmental evaluation would have considered further. Such issues include: external areas affected by the Project, both adjacent and downstream; fisheries; livestock; wetland ecology; river ecology and behaviour.

11.3 APPROACH AND SOURCES OF INFORMATION

FAP 12's environmental methodology has been described in detail in the Methodology Report. During the RRA surveys which were used a reconnaissance for the PIEs, an initial environmental screening and scoping were carried out to help identify the significant activities and issues for each project and the level of analysis required. This was followed up with a more detailed Preliminary Environmental Post-evaluation (PEP) as described below.

11.3.1 Preliminary Environmental Post-evaluation (PEP)

Preliminary environmental post-evaluation (PEP) has been defined here as the post-evaluation equivalent of environmental appraisal (as defined by ODA) or initial environmental examination (ADB). This is an intermediate level of post-evaluation, a main purpose of which is to identify projects which have had sufficient negative environmental impact to warrant a detailed environmental audit. In less extreme cases, the PEP should enable a more precise identification of any mitigatory measures required. Alternatively, the PEP may show that the project has proved environmentally sound and require little in the way of environmental monitoring and management.

The PEP approach proceeds beyond the screening-scoping activities of the initial RRA and is the environmental element of the PIE. In particular, more detailed and controlled information is acquired locally by systematic and structured interviews and multiple visits conducted by the FAP 12 PIE teams, while field observations and interviews are more intensive along carefully selected transects. The selection of transects is important because the PEP attempts to evaluate environmental impacts in terms of the different agroecological divisions, so that the transects must cross a representative selection of these, enabling contrasts and interrelationships to become apparent.

The PEP adopts different time and spatial perspectives to those of the PIE socio-economic surveys. The latter compare the Project Area with a purposively selected control area (see Section 11.3.5) for a specific crop year (Aus 1990 to Boro 1990/91 for Chalan Beel D). This permits comparison of with- and without-project scenarios. The PEP, on the other hand, retains the before-and-after approach of the RRA studies, thus confining itself to the Project Area and any external impact areas affected by the Project. The PEP also evaluates the environmental impacts of the Project over all the years since project completion (and where necessary any impacts during construction that are of long-term significance).

This enables the PEP to take account of certain impacts which the PIE surveys will miss. In addition, the PEP covers the ecological (i.e. physical and biotic) impacts of the

Project, as well as the human (largely socio-economic) impacts covered by the PIE surveys. The PEP takes advantage of the much more detailed level of the PIE findings with regard to human environmental issues. As the above comments show, however, the different temporal and spatial perspectives of the PEP and PIE surveys mean that their conclusions are not meant to be identical, but rather to complement each other.

11.3.2 Agroecological Divisions

The PEP is given its spatial structure by subdividing the project area into agroecological divisions (AED). The agroecological divisions used within the Project Area are the four AEDs defined in Section 11.1, with external (off-site) impact areas defined below in Section 11.3.3. The application of the AEDs requires clarification. Agroecological Divisions are dynamic, changing especially in response to human influence. Thus AED D, the permanent wetlands, is now much reduced in extent compared with pre-project (Figure 11.2). FAP 12 evaluation must be with conditions as they would have been now, given pre-project trends. Thus impacts assessed now for AED D have to be evaluated in terms of the changes that have occurred within AED D as mapped in Figure 11.2, as this would have remained the extent of the AED without the Project.

11.3.3 External Areas

The FAP 12 approach to environmental evaluation stresses the importance of taking into account not only environmental impacts within the Project Area, but also in areas outside it which are significantly affected by the Project. Project planning for Chalan Beel D and many similar projects in Bangladesh in the past has paid scant regard to such aspects. The projects originating with FAP clearly must improve on this.

External areas affected by Chalan Beel D can be grouped under three headings: the Sib River; the Atrai-Fakirni-Barnai Rivers; and the downstream Lower Atrai Basin. The project impacts in these areas are broadly assessed in Sections 11.4-11.6.

The Sib River area comprises not just the active river course but also the broad band of land flanking the Project's western embankment, where run-off from the high Barind Tract to the west ponds against the bund. The blocked head of the river and the high levels created by parallel bunding of the Atrai, Fakirni, Barnai and lower Sib mean that in fact the Sib barely flows at all during the monsoon, but rather forms an almost continuous series of beels along the embankment. Surrounding these, however, are considerable areas of cultivation and some sizeable settlements.

The Atrai-Fakirni-Barnai active courses are confined between parallel bunds to the east and south of the Project Area, often with reasonable set-back which allows cultivation (including sugar, jute, T. Aman) even during the monsoon in many places, and of wheat in rabi. The Atrai is the only one of the four rivers bounding the polder to be perennial. There is a good deal of settlement outside the bund still.

Parallel bunding and river flow concentration have precluded the flood attenuation that used to result from floodplain inundation. Thus hydrological conditions have greatly changed, especially downstream, as is apparent from FAP 12's RRA Report for the Nagor River Project.

11.3.4 Control Area

The Control Area is the incomplete section of the Barnai Project, immediately to the south east of Chalan Beel Polder D. This area has been used to provide the without-project comparison in the PIE socio-economic surveys (Chapter 1). For the reasons explained in Section 11.3.1, the Control Area has not been included in the environmental fieldwork, although the PIE findings there are taken into consideration in the impact assessment for many of the human environmental issues in Section 11.6.

The Control Area is of less value for the physical and biological assessments because ecologically it is not wholly comparable. It consists totally of high Ganges River Floodplain and contains none of the Atrai (Tista) Floodplain and Barind Tract agroecological subregions which account for over one-third (Table 11.1) of Chalan Beel Polder D.

11.3.5 Identification and Assessment of Environmental Impacts

The initial screening-scoping during the RRA has identified many of the significant environmental issues and impacts. The PEP uses a scaling matrix rather than a checklist, with the vertical axis comprising the issues already established and the horizontal axis consisting of the agroecological divisions (AED).

An attempt is made at scaling the **positive (+)** or **negative (-)** degree of impact as follows:

0 - nil or negligible impact
1 - minor impact
2 - moderate impact
3 - major impact

The rather simplistic scaling or scoring values reflect the essentially qualitative nature of PEP. They do have the advantages, however, of:

- ensuring that each primary impact is individually considered, while taking into account its often complex linkages with other primary impacts and with secondary or tertiary impacts;
- presenting a clear and very concise assessment, which is quickly and easily assimilated by the PEP user, enabling him to agree with or query it;
- avoiding voluminous and repetitious written presentations which soon become confusing, if not impossible, to read.

The environmental issues and related impacts are considered within three categories: physical, biological and human.

Some refinement in scaling can be imposed upon the three levels of impact by qualifying them as **strong** or **weak** at each level, although this is avoided so far as possible in order to retain clarity and conciseness.

Scaling of impacts is achieved by considering each impact within each AED or external impact area in turn and applying five **assessment factors**:

- magnitude (degree of impact);
- prevalence (extent);
- duration and/or frequency;
- risk of serious environmental damage;
- importance of the issue affected.

In addition, overall values are broadly assessed for the Project Area as a whole and collectively for the external areas.

Other important elements of the PEP approach include preliminary suggestions for means of mitigating the main adverse impacts, and recommendations for any future environmental monitoring or management requirements.

Methodology is discussed more fully in the FAP 12 Methodology Report (FAP 12, 1991b).

11.3.6 Sources of Information

The main existing sources of information have been the Feasibility Study by NEDECO (1979) and the evaluation studies by BETS/DPC (1989) and MPO (1990). Both the evaluation studies followed immediately on the two wet years of 1987 and 1988, when the Project effectively failed to function. The MPO (1990) report seems to be misinformed on cropping, unless very rapid changes have since occurred.

Other relevant sources have been: EPC (1989) - Hilna Beel Fisheries; EIP 1988 - Atrai-Nagar River Basin Studies; FAP 2 (1991) - North West Regional Water Development Plan (NWRWDP).

In addition the environmental evaluation, by its nature, relies heavily upon the work and findings of the engineering, agricultural, fisheries, livestock, institutional and sociological components of the FAP 12 team, by whom much of the new information synthesised here has been collected.

FAO (1988), as noted, appraised much of the pre-project ecological background.

11.4 PHYSICAL ENVIRONMENTAL IMPACTS

Physical issues have been subdivided into water-related and land-related (Table 11.2); other physical issues such as climate and atmosphere have not been affected by the Project.

11.4.1 Physical Impacts (Water)

a) River Flow

There are no active rivers within the Project Area, where the khals and abandoned river channels such as the Kompo River are included in the wetlands/waterbodies division (AED D).

Table 11.2: Physical Environmental Impacts.

Physical Issues	Degree of Environmental Impact								
	Project Area AED)					External Areas			
	A	B	C	D	Overall	Sib	AFB	DS	Overall
WATER									
a. River Flow	-	-	-	-	-	-2	-2	-3	-3
b. River Quality	-	-	-	-	-	-1	0	-2	-1
c. River Morphology	-	-	-	-	-	-2	-1	-3	-3
d. Flooding and Drainage	0	+1	+2	+3	+2	-2	-2	-3	-3
e. Groundwater Levels/Recharge	-1?	-1?	0	0	-1?	+1	0	+1	+1
f. Groundwater Quality	0	0	0	0	0	-1	0	0	-1
g. Wetlands and Waterbodies Extent/Recharge	-	-1	-1	-2	-2	+2	-	+1	+2
h. Wetlands and Waterbodies Quality	-	-	-1?	-1?	-1?	-1?	-	-1	-1?
LAND									
a. Soil Fertility	0	-1	-1	-1	-1	+1	0	+1	+1
b. Soil Physical Characteristics	0	0	0	+1	+1	0	0	-1	-1
c. Soil Moisture Status	-1	0	+1	+1	+1	-1	-1	-1	-1
d. Soil Erosion	0	0	0	0	0	0	0	0	0
e. Land Capability	0	+1	+2	+1	+1	-1	-1	-2	-2
f. Land Availability	0	+1	+2	+2	+2	-2	-1	-1	-2

Notes: AFB = Atrai-Fakirni-Baranai active river floodplains (within bunds)
DS = Downstream areas (Atrai Basin)
? = Uncertain impact

Source: Consultants

The main river flow parameters include discharge, velocity, timing, rate of rise and duration. In all of the river-related issues, the external impacts of the Project are considered as part of the impact of FCD projects in the middle Atrai Basin as a whole. This collective influence is seen as creating spatially cumulative impacts which cannot be realistically assessed for each project in isolation. If they were, then in each project they would appear to have only minor or even negligible impacts, masking the development of an increasingly hazardous regional situation. In view of the potential for wasted investment, damage and loss of life if present trends continues, it is vital that this does not happen.

The impact on the Sib River flow has been significantly negative. The volume of flow has been greatly increased by the embankment, which also influences its early and rapid rise. Meanwhile the high levels created between the parallel bunds in the Atrai-Fakirni Rivers and in turn in the Barnai, into which the Sib flows, pond back Sib movement so that its velocity falls to practically zero and its levels rise accordingly. Thus the Sib forms almost stagnant sheets of water for much of the monsoon and is a series of beels rather than a river. This was the case to some extent before the empoldering of Chalan Beel D began, so that only a moderate impact is registered. It is of interest to note that the Khari River, which flows north from near the Ganges to join with the Sib to form the Barnai at Polder D's south-west corner, was similarly virtually stagnant when observed in early July 1991.

The flows of the Atrai-Fakirni-Barnai (AFB) Rivers are also moderately negatively affected, in that their levels are raised by containment, which causes ponding, very slow flows and flooding along the Barnai. The Atrai and Fakirni set-back lands also suffer flooding in these middle reaches of the Atrai systems. This might be mild in most years but in wetter years such as 1987 and 1988, flows are very high and fast, causing a range of major negative impacts.

Further downstream, the impact of Chalan Beel D and associated projects is extremely negative, creating impossible hydrological conditions in the lower Atrai, Gur and Nagor (see FAP 12 Nagor River Project RRA Report). Consequently there are cuts and breaches in downstream embankments in most years, but especially in wet years like 1987 and 1988.

The environmental risk creation relating to river flows that is inherent in the Middle Atrai polders is alone enough to warrant assigning a major negative overall impact.

b) River Quality

Potential key quality factors are sewage, agrochemicals, sediment load (reflected by turbidity), and salinity.

Water quality in the Sib beels has probably deteriorated slightly due to the lessening of flushing of indiscriminate sewage and any agrochemical accumulation, although the latter is considered unlikely to be significant and the flushing action of the Sib since it was closed off has probably never been very effective.

The other three rivers are not thought to be greatly affected. Salinity is not an issue here and the increased bedload due to any scouring (Section (c)) is probably balanced by the contained flows.

Downstream the increased and rather coarse (fine sand rather than silt) bedload of the Atrai-Gur system causes considerable problems when it is deposited on good agricultural land.

Overall external impact on river quality is assessed as slightly negative.

c) River Morphology

River morphology changes mainly as a result of bank erosion, bed scour, or siltation. Clearly, in the quasi-stagnant situation in the Sib River, it is the last of these that provides the problems and is one of the major complaints by local people about the Project. Again, however, siltation must have been accelerating in the Sib once it was blocked off at its head. Heavy silt loads in run-off from the Barind Tract during rainstorms would previously have either moved downstream in raised flows or spread out across the floodplain to the east. The raised river levels downstream now prevent the former and the embankment prevents the latter, until it is cut. Since cutting seems to follow any really heavy run-off, the impact is probably only moderately negative, although clearly it would be worse if the Project always functioned as planned.

The Barnai probably suffers slightly from siltation in its upper reach, due to impeded flow, while the Atrai and at times the Fakirni must be affected by scouring of their beds at high flows. Scouring in these middle reaches increases channel capacity but also lowers the longitudinal gradient unless the rivers can be continuously contained downstream, which to date has not been possible in wet years. Eventually in any case there is the problem of maintaining an outfall into the main Jamuna. Scouring also increases bedload which, as noted in (b), causes downstream problems. On balance, a slight negative impact is assessed for the AFP Rivers, with a major negative impact on river morphologies in downstream areas, due particularly to bank erosion. Bank erosion is less of a problem in the AFP Rivers, due to the usually substantial set-back.

d) Flooding and Drainage

The Project was designed to provide flood control and drainage and so to have a comprehensive beneficial effect on the level, timing, rate of rise, duration and extent of flooding. MPO (1989) claim that this was achieved in 1985, but in the following four years the embankments were cut or occasionally naturally breached, and some cuts remain open to the present. This was especially the case in the two very wet years (1987 and 1988), with 33 cuts reported in 1987 alone. In addition, many of the sluices and regulators leak. Also, monsoon rainfall continues to create flooding in low-lying areas.

It is therefore, as noted, difficult to assess the impact on flooding, which is itself the primary impact causing many of the secondary and tertiary impacts within the Project Area. Assessment is helped by looking at the different AEDs separately, and ensuring that it is the actual impact which is assessed.

AED A has not been much affected. Some parts adjacent to the Atrai have suffered localised floods from cuts and in the drier conditions of 1990 the droughty tendency of the soils would have been emphasised. Generally, however, what limited flood risk there was previously has now largely disappeared. On balance, the net effect is negligible, but would be slightly positive without cuts.

In AED B the impact varies between the ridges, where it is similar to AED A, and the basins, where it resembles AED C.

In AED C a moderate positive impact is assessed. To arrive at this assessment, it is first necessary to define what is considered positive and what negative, because these floodplain depression areas are obvious scenes of conflicting interest between cropping on the one hand and fisheries and grazing for livestock on the other. Given the aims of the Project to achieve flood control, then a physical impact achieving this must be regarded as positive overall, even though certain negative secondary impacts will result.

In the last two years it seems evident that the embankments are beginning to achieve their basic aim of reducing if not wholly controlling flooding, hence the moderate positive impact. Even so, there will be numerous years within the 1:100 year design scenario when cuts will lead to rapid flooding. Thus flooding in 1987 and 1988 seemed to be worse than pre-project due to the rapid rate of rise following cuts and the prolonged duration due to the generally ineffective drainage systems. If solutions to external impacts could be found to deter the cuts and, then the moderate flooding impact would become major.

In AED D, the decreased flooding and reduced extent of AED D make the positive impact even more pronounced, despite the cuts, breaches and inadequate drainage.

Overall within the Project Area, a net moderate positive impact is registered, given the Project's inadequate performance.

The external impacts on flooding are implicit in the previous discussions on river flow in (a) above, and so have the same values. It is the rapidity of flooding downstream, as well as the increase in extent, that is the problem when embankments are cut or breached, as happens in wet years. In Sib area also it is both of these factors.

e) Groundwater Levels

This is an important issue because of the rapid spread of shallow tubewell irrigation in the Project Area, especially for HYV Boro. However, it is difficult to detect any immediate trends as this is a relatively long-term phenomenon and the Project has had only three reasonably effective years prior to 1991.

Even so, there are reports of declining water levels in wells on the higher ground of AED A and the ridges in AED B, where shallow wells are widely used for drinking supply and increasingly for irrigation. Deep-set shallow tubewells are common in the area. This may reflect the 1990 dry year or simply overpumping from the rapidly increasing spread of both STW and DTW throughout much of the polder. A minor negative impact is guessed at in AEDs A and B but needs much more investigation. Monitoring of groundwater levels is essential for the long-term agroeconomic security of Polder-D (and many other areas of Bangladesh). As yet, it is difficult to detect an impact in the lower areas.

Externally, along the Sib, the area must benefit from groundwater recharge due to increased flooding. The active AFB River floodplain will not be significantly affected. Downstream areas have benefited slightly because floods in 1987 and 1988 will have increased recharge, something which is certain to recur in future wet years. This will help to balance the recharge lost during drier years due to the protection of the downstream bund.

f) Groundwater Quality

There has been a considerable increase in population and also in the use of agrochemicals, especially fertilisers, for paddy. Given natural filtration and adsorption, it is not expected that increased indiscriminate sewage will reach the groundwater. There is a minor danger of nitrate pollution from fertilisers but this is unproven and requires measurement and monitoring. In any case, neither trend is due to the FCD component of the Project, but rather to the two really major influences in the area: the improved road system and the rapid spread of tubewell irrigation. Some increased use of fertilisers is likely to have resulted from the apparent switch from B. Aman to T. Aman (which is a project effect) but this is not considered significant as yet.

In the Sib area the larger extent and longer duration of standing water will increase groundwater recharge, as seen in (c), and so encourage more of the increasingly polluted water (Section (h)) to reach the watertable. In the active river courses and downstream areas, groundwater quality should not be affected by the Project.

g) Wetlands and Waterbodies Extent and Recharge

Since by definition the major wetlands and waterbodies form AED D, this is the division mainly affected within the area. Clearly, as noted from the discussion in (d), there has been a substantial negative impact, which would be even greater if the Project functioned as planned. In addition, the smaller, scattered seasonal wetlands in AED C and in some AED B basins have diminished or disappeared.

In the Sib area, where several large beels pre-dated the Project, these have just as clearly benefited and are considerably more extensive. Downstream of the Project, there has been a similar but lesser impact, as flooding in 1987 and 1988 increased in extent as more water was funnelled down the Atrai system.

h) Wetlands and Waterbodies Quality

Accumulation of rain-washed indiscriminate sewage and especially of leached fertilisers and other agrochemicals has continued to take place in AED D but in much smaller volumes of water, with consequent reduced dilution, and with no prospect of any flushing out of the area. This is, however, a problem that is often popularly exaggerated in the developing world, where agrochemical usage is low, even though applications may be inefficient and encourage losses. A minor negative impact is assumed in AED D and parts of AED C but really requires substantiation and monitoring. The increased use of agrochemicals is mostly unrelated to the Project.

The situation is similar in the Sib area beels, which now are really indistinguishable from the river. In wetlands downstream, a similar impact is assumed, due to increased extent of flooding in wet years such as 1987 and 1988.

11.4.2 Physical Impacts (Land)

a) Soil Fertility

The main influence of the Project on soil fertility has resulted from the contraction of the flooded area and the switch from B. Aman to T. Aman, in AED C and the basin areas of

AED B. The flooded areas supported B. Aman and aquatic weeds on which the blue-green algae flourish that are purported to supply nitrogen to the soil. The rotting of all this organic matter also contributed to soil fertility. Annual depositions of silt, on the other hand, are considered to contribute little to soil fertility, despite farmers' insistence otherwise. A minor negative impact is assumed. The rarely flooded AED A is not significantly affected.

A similar impact occurs in AED D, where part of the original permanent wetland has been converted to seasonal flooding, often with cultivation.

In the Sib external area the extended flooded area should have a net minor positive impact, which has been similarly repeated in the increased flooded area downstream of Chalan Beel D in 1987 and 1988.

b) Soil Physical Characteristics

Seasonal drying out in AED D areas that were previously flooded has created a minor impact in the Project Area in improving soil physical characteristics, especially structure. The only significant external impact in this respect is likely to be a minor negative effect in the external downstream areas, where the slightly coarser Atrai-Gur bedload is deposited to form topsoil during wet year flooding.

c) Soil Moisture Status

This has suffered a slight negative impact in the higher areas (AED A and the AED B ridges) because of the decreased flooding. An effective drainage system might accentuate this, but drainage does not seem likely to be improved at present. The overall effect in the depressions (AED C and AED B basins) and the seasonally exposed parts of AED D has been slightly positive, as some soils have become available for early rabi cropping which previously remained wet too long.

In all the external areas the increase in flooding has meant a slight increase in soil waterlogging persisting too long in places, although this has happened only in the 1987 and 1988 wet years in the downstream areas.

d) Soil Erosion

This is a negligible issue in an area as large as Chalan Beel, as it relates mainly to erosion of the embankment, which here is only a tiny proportion of the area. In many stretches the embankment has been protected by afforestation. No project-induced soil erosion occurs in the external area.

e) Land Capability

The net impact on land capability in AED A has been negligible because this division has not been greatly affected by the Project. In AED B the reduced flooding of the depressions has outweighed the one or two very minor negative effects to give a net slight positive impact on land capability. In the larger depressions of AED C this increases to a moderate positive impact and could be major if the originally planned degree of flood control is eventually achieved.

A similar impact would occur in AED D due to the improved capability of the substantial area exposed for seasonal cropping, but is reduced by the loss of fishing and grazing capacity to only minor positive.

The overall impact at present within the Project Area is probably minor rather than moderate positive, but as noted may improve further eventually. Increases in depth of flooding have reduced land capability in the adjacent off-site areas, but only slightly, In the downstream areas the negative impact is moderate, due to the high frequency and risk of flooding caused by Chalan Beel Polder D and related projects.

f) Land Availability

This is not affected in the relatively high lands of AED A and the AED B ridges, but has increased significantly in the depressions of AED C and the AED B basins. The decreased extent of AED D (which is now a good deal less than shown pre-project in Figure 11.2) has also made land available within AED D, and so constitutes a moderate positive impact.

Externally, the Sib area has clearly lost a good deal of land to flooding. A small decrease in land available for cropping must have occurred within the contained active flood plains, while in downstream areas the increased flooding would also have slightly diminished the extent of available land, due mainly to 1987 and 1988.

11.5 BIOLOGICAL ENVIRONMENTAL IMPACTS

Biological environmental issues affected by the Chalan Beel D Project can be divided into fauna and flora issues. Most have suffered either insignificant or slight impacts but are briefly examined because of the popular awareness of such issues. The main areas of natural biological activity are the wetlands; elsewhere pre-project population density and land use intensity had already largely destroyed the natural environment.

A basic problem in evaluating the biological impacts of either population growth or the Project is the lack of any data from any previous points in time. There is a general claim that at some ill-defined time in the past, birds, fish and other wildlife flourished in large numbers, but no quantified baselines exists, either now or for any previous time. The only broad numerical data available relate to fish catches in some areas of Bangladesh and these effectively show only what at a given time fishermen wished or were able to catch. Thus, all assessments in this section are based on inference and hearsay, regarding past biotic baselines.

11.5.1 Biological Impacts (Fauna)

a) Bird Communities/Habitats

It is reported locally that only ten years ago there were still substantial numbers of birds, especially migratory waterbirds, congregating fairly early and late in the dry season in the beels. Numbers are now said to be significantly less, and the reduction in the wetlands extent is given as one cause. However, the decline must have been considerably advanced immediately pre-project and has been hastened subsequently mainly by population growth and improved communications, neither of which relate much to the FCD project component.

A weak slight negative impact, especially in the wetlands (AED D), seems likely. Any complementary positive impact in the Sib area, where wetlands seem to have increased, is obviated by even stronger trends in population density and improved access. Wet year floods in the downstream areas have probably not had any significant affect.

b) Fish Communities/Habitats

There has been a general negative impact on fish ecology due to the reduction of flooded area and depth and in interruption of spawning and recruitment for the major species, especially the carps, by the construction of the embankments. This does not affect AED A but becomes increasingly important as the proportion of protected, previously flooded land increases through AEDs B, C and especially D.

The fish ecology in the beels is deteriorating because the beels are becoming cut-off from both the rivers and from each other, but also because of the increasing number of fishermen. Even those species that might breed within the beel, without having to migrate, are suffering from overfishing and impoverished foodchains and nutrient status within the beels. However, any decline has to be set against the deterioration in fish ecology that had already occurred pre-project due to the Sib blockage and to increasing overfishing, and since 1988 to the considerable impact of the ulcerative fish disease that has swept the whole of Bangladesh.

An improvement may have occurred in the expanding Sib beels, but this has to be set against the generally impoverished and declining fish ecology that has developed there, since it was cut off from the Atrai, which will be accentuated by being separated now from the beels inside the bund. Differences in the AFB Rivers and downstream areas due to the Project are probably not significant either.

c) Other Macro-fauna Communities/Habitats

Similar comments apply as for (a) above, except that overall the impact is too weak to be significant. Already by 1985 the intensive occupation and utilisation of the land had severely reduced the populations of mammals, reptiles, amphibians, etc.. The continued decline during the Project's life may have been slightly accelerated by the Project, where fauna depend on the shrinking beels. The main causes, however, have been increased population and access, both within the Project Area and externally.

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, rather than relying on hearsay.

d) Micro-fauna Communities/Habitats

This issue has already been touched upon in Section 11.4.2 (a), where negative changes are inferred with respect to the incidence of blue-green algae, one of the major microbiota elements in Bangladesh. In the total absence of data, it is assumed that other microbiota are similarly affected by the Project, so that impacts are much the same except in AED D.

Table 11.3: Biological Environmental Impacts

Biological Issues	Degree of Environmental Impact								
	Project Area (AED)					External Areas			
	A	B	C	D	Overall	Sib	AFB	DS	Overall
FAUNA									
a. Bird Communities/Habitats	0	0	-1	-1	-1	0	0	0	0
b. Fish Communities/Habitats	0	-1	-2	-2	-2	0	0	0	0
c. Other Macro-Fauna Communities/Habitats	0	0	0	-1	0	0	0	0	0
d. Micro-Fauna Communities/Habitats	0	-1	-1	-2	-2	+1	0	0	+1
FLORA									
a. Trees	+1	+1	+1	+1	+1	0	0	0	0
b. Other Terrestrial Vegetation	0	0	0	0	0	0	0	0	0
c. Aquatic Vegetation	0	0	-1	-2	-2	+1	0	0	+1

Notes: AFB = Atrai-Fakirni-Baranai active river floodplains (within bunds)
DS = Downstream areas Atrai (Basin)

Source: Consultants

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In the beels the situation is more serious. The reduction in the area flooded by the beels has led to a considerable reduction in the amount of organic material and nutrients washed back in to accumulate in the beel as flooding recedes. This accumulation is a major source of the beel's biota, which in turn are vital links in the foodchains of fish, birds and other fauna. This wider floodplain inundation also provided rich seasonal feeding and spawning grounds for beel resident species. There seems little doubt that the cut-off beels are becoming seriously impoverished and that this may be the main problem with the decline of species that will breed in the beels. If so, this constitutes a moderate negative impact to date, which will become worse if the embankments eventually provide a more permanent barrier.

In downstream external areas, micro-fauna in wetlands and rivers are unlikely to have been significantly affected by the wet-year increases in wetland extent, although a minor positive impact probably occurs in the Sib.

11.5.2 Biological Impacts (Flora)

a) Trees

The populations in the area have not been affected by the Project, although the embankments have provided an excellent opportunity for afforestation. Acacia nilotica and Dalbergia sissoo form dense growths of trees along some stretches of embankment throughout the area (as do lengthy stretches of roads).

b) Other Terrestrial Vegetation

No impact, as natural non-aquatic vegetation had already greatly diminished pre-project.

c) Aquatic Vegetation

The communities and habitats of aquatic vegetation are found largely in AED D, where the reduction in the extent of permanent water has had a moderate negative impact. Scattered, smaller wetlands in AED C are also affected.

Externally, the complementary positive impact in wet years 1987 and 1988 in downstream areas is assumed to be negligible, but slightly positive in Sib area, where the spread of wetlands has been significant.

11.6 HUMAN ENVIRONMENTAL IMPACTS

Some of the most important environmental impacts of the Chalan Beel D Project are those affecting the human environment. However, many of these are covered in other chapters of this report. Here they are presented in Table 11.4 and are in most cases only briefly summarised below.

Human impacts can be conveniently grouped into five sub-categories: human use, social, economic, institutional, and cultural. Consideration of human impacts in terms of the different AEDs and external areas adds a distributional perspective to the more detailed discussions elsewhere in this report.

11.6.1 Human Use Impacts

a) Crop Cultivation

Chapter 4 shows that the Project is now beginning to cause a change from B. Aman to T. Aman in AED C, and the basins of AED B. AED A is not greatly affected, while in AED D the scope for low-lift rabi irrigation of land now seasonally exposed is another positive impact. The uneasy initial project years, when cuts were so common, delayed this trend (BETS/DPC, 1989), so that to date the impacts have been limited, although they can be expected to grow.

Externally, cultivation in the Sib area suffers considerably from the loss of cropland to flooding. In the AFB Rivers active floodplain, higher levels probably slightly inhibit cultivation. Several downstream areas have suffered crop problems and losses due to the collective impacts of projects such as Chalan Beel D (notably Chalan Beel C, Nagor Valley and Nagor River), especially in 1987 and 1988.

b) Livestock

Some increase in small stock is reported (Chapter 5), along with benefits from use of the embankment for grazing and security from the floods. However, livestock was not taken into account in project planning and the main impacts, on numbers, health and strength of cattle and buffalo, seem to have been negative. The main cause is the loss of traditional grazing lands around beels, previously too insecure for cropping. The impact therefore centres on AED C and to a lesser degree on the AED B basins. The impact will increase if protection security is improved further. On the other hand, it may well be exaggerated, with other factors being the main cause of the decline, notably a growing preference for the use of power tillers. Also, the reduced extent of perennial flooding in AED D frees some lands there for dry-season grazing, creating a minor positive impact. The overall impact in the Project Area is probably balanced.

The extended flooding in Sib area has presumably encouraged grazing at the expense of crops. A similar effect in downstream areas would be only negligible.

c) Capture Fisheries

Chapter 6 covers the very marked decline in capture fisheries and corresponding increase in culture fisheries. Impacts noted in Sections 11.4.1 (g) and (h), 11.5.1 (b) and (d), and 11.5.2 (c) are all relevant.

The decline, as would be expected, has its main negative impacts in AED D and C, and to a lesser extent AED B, where floodplain fisheries would be proportionately less extensive. The decline due to the Project is less than might be expected because:

- the Project has so far not been wholly efficient in controlling flooding;
- beel and floodplain fisheries have been in decline for some time prior to the Project.

This last factor largely accounts for the generally negligible impact in the external areas (see 11.5.1 (b)).

Table 11.4: Human Environmental Impacts

Human Issues	Degree of Environmental Impact								
	Project Area (AED)					External Areas			
	A	B	C	D	Overall	Sib	AFB	DS	Overall
HUMAN USE									
a. Crop Cultivation (including irrigation)	0	+1	+1	+2	+1	-2	-1	-3	-3
b. Livestock	0	-1	-1	+1	0	+1	0	0	+1
c. Capture Fisheries	0	-1	-2	-2	-2	0	0	0	0
d. Culture Fisheries	0	+1	+1	0	+1	0	0	0	0
e. Afforestation	+1	+1	+1	+1	+1	0	0	0	0
f. Agro-industrial Activities	0	0	0	0	0	0	0	0	0
g. Transport Communications	+1	+1	+1	-1	+1	0	0	0	0
h. Infrastructure	0	0	0	0	0	-2	-2	-3	-3
i. Domestic Water Supply	-1?	-1?	0	0	-1?	+1	0	+1	+1
j. Sanitation	0	-1?	-1?	-1?	-1?	-1?	0	0	-1?
k. Recreation	0	0	0	0	0	0	0	0	0
l. Energy	0	0	0	0	0	0	0	0	0
SOCIAL									
a. Human Carrying Capacity	0	+1	+2	+1	+1	-1	-3	-3	-3
b. Demography	0	0	0	+1	0	-1	-2	0	-1
c. Gender	0	+1	+1	0	+1	0	0	0	0
d. Age	0	0	0	0	0	0	0	0	0
e. Health and Nutrition	0	0	0	0	0	-1	-1	-3	-3
f. Disruption, Safety and Survival	0	0	0	0	0	-2	-2	-3	-3
g. Land Ownership	-1	-1	-1	-1	-1	-1	-1	0	-1
h. Equity	0	-1	-2	-2	-2	-2	-2	-2	-2
i. Social Cohesion	0	-1	-2	-2	-2	-3	-2	-3	-3
j. Social Attitudes	0	+1	+1	0	+1	-2	-2	-3	-3
ECONOMIC									
a. Incomes	0	+1	+1	+1	+1	-1	-1	-3	-3
b. Employment	0	+1	+1	+1	+1	-1	-1	-3	-3
c. Land Values	0	+1	+1	+1	+1	-1	-1	-3	-3
d. Credit Availability	0	+1	+1	+1	+1	0	0	-1	-1
INSTITUTIONAL									
a. Institutional Activity/Effectiveness	0	-1	-2	-2	-2	-2	-2	-2	-2
b. Public Participation	0	-1	-2	-2	-2	-3	-3	-3	-3
CULTURAL									
a. Historical/Archaeological Sites	0	0	0	0	0	0	0	-1	-1
b. Cultural Continuity	0	0	0	-2	-2	0	0	0	0
c. Aesthetics	0	0	0	0	0	0	0	0	0
d. Lifestyle (Quality of Life)	0	+1	+1	+1	+1	-1	-1	-3	-3

Notes: AFB = Atrai-Fakirni-Baranai active river floodplains (within bunds)
DS = Downstream areas (Atrai Basin)

d) Culture Fisheries

Chapter 6 demonstrates the considerable upsurge in cultured fishponds and nurseries in the Project Area, which in the intermediate low-lying areas might represent a minor positive impact of the Project. The Project has provided a degree of protection and confidence, but the main impetus for culture fisheries is economic and technological. The same trends occur in Sib, on a lesser scale, and in other external areas, where the Project cannot claim any positive impact.

e) Afforestation

Throughout the area, afforestation has been successfully implemented along many stretches of the embankment. It is also common along the new roads, but these are not part of the FCD component. No significant afforestation results outside the bunds.

f) Agro-industrial Activities

Although a considerable development in agroindustrial activities has taken place in Chalan Beel D, this is largely due to other factors, notably better roads and tubewell irrigation. Thus the Project cannot be said yet to have had a significant impact on agro-industries, either within or outside the Project Area.

g) Transport and Communications

This assessment ignores the enormous positive impact of the new roads (Chapter 8) provided by a separate component of the Project. It is thus mainly concerned with kutcha roads and tracks and with water transport, plus of course the role of the embankment itself. The existing road system has benefited where flooding is less, while boat transport has correspondingly declined, as boats can no longer enter the area from the rivers and water levels are lower. This balance is reflected in the assessments for the different AEDs within the area and for the Sib and downstream external areas. There may be an improvement in boat transport in the active river courses due to higher river levels and a slightly prolonged season on the non-perennial Fakirni and Barnai, but this is probably not significant. The embankment is not motorable in all sections, although much of it is. In any case it provides a significant positive impact on communication and access, including in the adjacent riverine areas.

h) Infrastructure

The partial control of floods may have had small benefits but in fact the floods that are really damaging to houses, factories and other infrastructure will still occur, either due to public cuts and breaches or to above-design floods. Thus no significant impact is assigned. Chapter 8 discusses infrastructure further.

The Sib area has suffered significantly in this respect, hence the public cuts in the west, which have usually resulted when houses were threatened. Similarly, houses on the contained active floodplain are now threatened by rising flood levels. In downstream areas generally, again the collective effects of the Middle Atrai polder schemes constitutes a cumulative impact of Chalan Beel D, with the high risk that cumulative impacts imply. The damage to downstream infrastructure in 1987 and 1988 was enormous and is likely to be worse in similar wet years in the future.

i) Domestic Water Supply

The discussion in 11.4.1 (e) indicates the various impacts here, which relate essentially to the Project's possible effect on groundwater recharge. However, it is stressed that this effect still has to be demonstrated and also that it could be a good deal worse, within the area.

j) Sanitation

The main fear here is that the embankment prevents the previous flushing action to clear accumulated sewage pollution in the low-lying areas and beels. The same problem is likely to occur in the Sib external area because of the now virtually stagnant river, although it was probably never very efficient in this respect. Lack of data makes the implied negative impact uncertain.

k) Recreation

No significant impact.

l) Energy

No significant impact.

11.6.2 Social Impacts

a) Human Carrying Capacity

The increased land capability and availability have achieved a similar increase in population capacity (see Sections 11.4.2 (e) and (f)), although full advantage has yet to be taken of this, due mainly to uncertainty over public cuts. Overall, the impact is currently limited to a minor level due to this uncertainty and also to the negative influences of declining capture fisheries and possibly livestock. Again, other factors have recently been much more powerful influences on social issues in the Project Area.

The Project has had a minor negative impact on Sib area and major negative impacts on the active floodplain and especially the downstream areas.

b) Demography

The Project itself has probably not significantly influenced demographic structure and trends, except as in (a) above. Even then population growth and demographic structural changes have not been significantly directly influenced by the FCD Project and are due much more to better roads and irrigation.

There has probably been out-migration from the Sib and active floodplain areas, especially of younger people, so that some negative impacts occur there.

c) Gender

A minor positive impact may have been achieved on the role of women in some parts of the Project Area, by creating greater employment opportunities - see Chapter 8.

d) Age

No real impact occurs, unless the increased agricultural activity within the Project Area takes children out of school too early.

e) Health and Nutrition

A minor negative impact occurs in AED A and higher parts of B due to possibly reduced drinking water supply from the shallow tubewells - see Section 11.4.1(e). Balancing this, the substantial reduction in perennial wet areas should reduce malaria and other waterborne diseases and increased cropping has increased food supplies. Conversely, if the much less efficient flushing effect of the floods on sanitation is significant, there is another negative impact, to which the decline in fish and livestock protein for the poorer sections of the community needs to be added. This array of conflicting factors suggests that overall there is no significant impact (see Chapter 9).

In the Sib external area the increased extent of water and reduced cropping indicate a slight negative impact. In the downstream areas and the contained floodplains the collective impact in 1987 and 1988 caused injury and even death, as considered in (f) below, as well as increased sickness and disease.

f) Disruption, Safety and Survival

As discussed in Section 11.6.1 (h), the situation regarding dangerous floods has not changed in the area, and may even be considered worse, due to the sudden nature of public cuts and breaches, although on a more localised scale than natural floods. Impacts are therefore similar to those for infrastructure, with no significant change within the area but substantial negative impacts off-site.

g) Land Ownership

This appears to be unaffected as yet, except for the general minor negative impact caused in both the Project Area and adjacent riverine areas by the acquisition of land for the embankment.

h) Equity

There has inevitably been an inequitable distribution of gains and losses. Those who could afford to take advantage of newly available land, improved input opportunities, and especially tubewell irrigation and culture fishery in now-protected areas have flourished. The losers are particularly the traditional fisherman and also the poorer farmers and livestock owners. Chapter 9 examines this important aspect in more detail. The impacts are greatest in AED D and C, and the lower parts of B, although again many of the impacts increasing inequity in the Project Area are not related to the Project, as assessed here.

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Similarly in the external areas, there are those who have been able to avoid the Project's negative effects while profiting from it overall, notably by owning land on both sides of the embankment. Others have lost much of what little they had. An overall moderate negative impact has resulted.

i) Social Cohesion

Social cohesion has suffered from the negative impacts on equity noted in (h) above. There is much resentment amongst the losers, especially the traditional fishermen. Similarly, in places along the bund in Sib area where not much land is owned on the other side, there is considerable disagreement. The public cuts illustrate this. There is also resentment by people in the south east whose land is flooded from the Sib side, who then create further social discord by cutting the eastern embankment and passing the problem into the active floodplain and ultimately into the downstream areas, The substantial negative impacts on social cohesion are partly due to the poor institutional performance noted in Section 11.6.4 below.

j) Social Attitudes

Not surprisingly, the impacts on social cohesion and equity result in much antipathy to the Project on the parts of the losers i.e. traditional fishermen, livestock owners, and people in low areas an either side of the embankment where there is a regular threat of cuts or breaches.

On the other hand, the large majority of people in the Project Area benefit from the Project, if only to a limited extent, and there is a general increase in confidence in those areas where damaging floods are now rare. Thus the net impact is positive, except in AED D, the previous preserve of the traditional fishermen, and even here there are farmers benefiting.

In the external areas, of course, the Project and others like it are resented by those directly affected or who can grasp the cumulative risk inherent in the present Middle Atrai development programme. In 1987 and 1988, social attitudes in these areas would have been extremely negative.

11.6.3 Economic Impacts

The three main potential economic impacts on the people are incomes, employment and land values. These have all received at least minor positive impacts except in AED A, which has not been significantly affected. The net minor impacts are the result of cultivation benefits reduced by the losses from fisheries and livestock, especially in AED D. The losers, in this respect, have been the traditional capture fishermen. Credit availability should have increased to reflect the overall economic improvement (which has received much greater positive impacts from irrigation and roads).

Corresponding minor negative economic impacts occur beyond the bund in the Sib area, where the situation is alleviated by the numerous people who own land on both sides of the embankment. A similar situation occurs within the AFB Rivers active floodplain, where increased flooding inhibits land use but again people benefit from their land on the other side of the bund. In the downstream areas, substantial economic losses result in wet years from the collective impacts of projects such as Chalan Beel D. Creditworthiness is likely to have suffered slightly in the downstream areas.

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11.6.4 Institutional Impacts

All FCD and FCD/I projects assume in their planning and design a high level of institutional activity and effectiveness, especially within the main institution concerned, the BWDB, but also the DAE. Sometimes the DoF is also included in the local institutional strengthening that is implicit in and planned by the Project. In defining institutional impacts by the Project, positive impacts are recognised where performance exceeds the planned levels and achievements and negative impacts where these fall short. Institutional impacts arise, therefore, due to the success or otherwise of project management.

Institutional effectiveness does not seem to have improved as a result of the Project. It is particularly relevant in the low-lying areas (AEDs D, C and parts of B) and the external areas, where the Project has created problems for some people (notably the capture fishermen) within the area. The capability to maintain and operate both the flood protection and drainage elements of the Project seems lacking, with no possibility of avoiding public cuts in wet years yet in sight.

The continuing threat of public cuts exemplifies the negative institutional impact on public participation, especially outside the bund (although some cuts, especially in the south east, are from the inside, to relieve drainage congestion following cuts in the west).

Chapter 3 provides more details on the institutional performance of the Project.

11.6.5 Cultural Impacts

It is difficult to see that the Project has significantly influenced cultural heritage or scenic qualities in the Project Area. There are no particular historical, archaeological or more recent cultural sites within the area or in the adjacent external areas. However, there must be a slight risk of the increased flooding in downstream areas threatening mosques and other cultural sites in places, as presumably happened in 1987 and 1988.

Cultural continuity is threatened, in the beel areas (AED D) especially, because of the impending demise of the traditional capture fishing communities. Usually these are Hindu and add to social and cultural diversity. Many are now either going elsewhere, often to India, or forsaking their traditional ways to become labourers.

Quality of life has overall improved slightly in those parts of the Project Area affected by the Project, although, irrespective of the FCD component, the improved roads and increasing tubewell irrigation have been the real causes of the much higher standards of living and quality of life apparent today, when compared with the description of the area in the Feasibility Report (NEDECO, 1979).

In the Sib and active floodplain areas, the Project has probably had a slight negative impact, although obscured by the general increase in prosperity. In the downstream area, the collective effect of projects like Chalan Beel D has been to impose considerable damage and threat to the quality of life, notably as discussed Section 11.6.2 (f) above and in more detail in the FAP 12 Nagor River Project Environmental Evaluation.

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11.7 ENVIRONMENTAL SCREENING

The primary project activities were flood protection, drainage and controlled run-off retention for irrigation. The scoping exercise in Sections 11.4-11.6 shows that none of these has been fully achieved. The threat of catastrophic flooding remains, albeit on a generally more localised scale, during really wet years, due to cuts and breaches. Drainage systems are suffering from siltation and poor operation and maintenance of khals and structures (Chapter 4). Run-off retention for irrigation is locally successful and in general the embankment must slow run-off to some extent, although without allowing any control.

The environmental screening of project activities implicit in Sections 11.4-11.6 shows that the component responsible for most environmental impacts, positive and negative, is flood protection. Drainage and controlled run-off retention at present appear to be largely ineffectual.

11.8 CONCLUSIONS AND RECOMMENDATIONS

11.8.1 Conclusions

Conclusions can be summarised in terms of the main environmental impacts of the Chalan Beel D Project in the Project Area and the external impact areas. Environmental impacts have been assessed by environmental scoping in Sections 11.4-11.6 and are presented in Tables 11.2-11.4. They relate to the AEDs defined in Figure 11.1 and Table 11.1.

a) The Project Area

There have been no major and only two moderate positive net impacts in the Project Area overall. The latter were the impact on flooding and the increased land availability especially in AEDs C and D. Most positive impacts are only minor, partly because the Project had only been in operation for five years prior to 1991 but particularly because it has failed in critical wet years (notably 1987 and 1988) to achieve its planned objectives. This has been due largely to public cuts in the embankment and occasional natural breaches due to poor design and construction, as well as to inadequate drainage causing drainage congestion within the bunds.

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 and vegetation (AEDs D and C);
- the resulting decline in capture fisheries (AEDs D and C);
- marked deterioration in social cohesion and equity (AEDs C and especially D);
- the failure to achieve institutional effectiveness and to encourage public participation (AEDs C and D);
- the threat to the cultural traditions of the largely Hindu capture fishermen (AED D).

AED A has not been significantly affected because it was rarely seriously flooded pre-project. In AED B, the basins have generally had similar impacts to AED C and the ridges to AED A.

b) External Impact Areas

Tables 11.2 -11.4 show clearly that the Project has had much greater negative impact beyond its boundaries, in the adjacent Sib area and especially in areas downstream in the Atrai Basin. Many of the impacts in the latter areas are attributable to the collective impact of the Middle Atrai polder schemes, of which Chalan Beel D is one. However, the cumulative off-site environmental risk implicit in these schemes is such that they must be assessed collectively, to reveal the considerable environmental hazards involved.

There are no moderate or major positive impacts due to the Project in the external areas, and very few minor ones.

The Sib area suffers numerous moderate negative impacts and occasional minor ones (Tables 11.2-11.4). Problems arise primarily due to the embankment creating a barrier to run-off from the Barind Tract in the west and to high river levels in AFB Rivers preventing any real flow in the series of beels that was once the Sib River.

The active floodplains of the AFB Rivers, contained within parallel bunds, have not benefited from the Project but suffer a number of moderate negative impacts, due largely to higher river levels.

It is in the downstream areas in the Atrai Basin that the majority of severe impacts arise (Tables 11.2-11.4). Concentration of river flows and prevention of flood attenuation in the Middle Atrai creates major threats downstream of catastrophic flooding, even in years that are well within the theoretical design of downstream projects (because these are individually calculated in situ for each project, thus ignoring the cumulative upstream threat).

As a result, cropping, infrastructure, population capacity, health, social disruption and even survival, social cohesion and attitudes, economic parameters, public participation, and the overall quality of life all suffer serious negative impacts. The events of 1987, especially bad in the North West Region, and 1988 were representative of many of these negative impacts. They will recur, and more frequently, if the uncoordinated empoldering of the Middle Atrai continues.

11.8.2 Recommendations

Recommendations are stated below.

i. Design and implementation of a long-term integrated plan for the coordination of development in the Atrai Basin as a whole (possibly to be provided via the North West Regional Water Development Plan, FAP 2, 1991).

ii. Rehabilitation of the cuts, drainage systems and structures to allow the Chalan Beel Polder D Project to perform as planned.

iii. Measures to mitigate or directly compensate the unacceptable inequity of the Project impacts as between outsiders and insiders, without which (ii) will not be feasible.

iv. Establish monitoring programmes now for certain critical environmental parameters, including: groundwater levels and quality; wetlands extents and quality; wetlands wildlife including fish, and micro-biota.

v. Given (ii) and (iii), a detailed environmental evaluation i.e. environmental audit) about five years after their completion, presumably by FAP 16 or its counterpart agency.

None of (i) - (iv) above is easy and there are no obvious solutions immediately to hand. They represent some of the key challenges faced by the current FAP programme, as they highlight major shortcomings in previous FCD development.

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ESOTERIC ACRONYMS

EIA	Environmental Impact Assessment;
IEE	Initial Environmental Examination;
AFB	Atrai, Fakirni and Baranai;
AED	Agroecological Divisions FAP 12);
AER	Agroecological Regions FAO, 1988);
AES	Agroecological Subregions FAO, 1988);
PEP	Preliminary Environmental Post-evaluation FAP 12);
NWRWDP	North West Regional Water Development Plan FAP 2).

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