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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

6

PROJECT IMPACT EVALUATION OF KURIGRAM SOUTH PROJECT

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February 1992

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in association with

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Flood Hazard Research Centre
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Kurigram South Unit

Project Summary Sheet

Project Name	: Kurigram South Unit
Project Type	: Flood Control and Drainage
Location	
FAP Region	: North-West
District	: Kurigram and Lalmonirhat
Area (ha.)	: 63 000 ha. (gross) 50 000 ha. (cultivable)
Funding Agency	: Government of Bangladesh
Implementing Agency	: BWDB
Construction started	: FY 1975
Scheduled Completion	: FY 1982 (eight year construction period)
Actual Completion	: FY 1984 (FCD component)
Original Cost Estimate	: Rs 232.46 million (1971 prices)
Final Cost Estimate	: Tk. 683.6 million (1991 prices)
Major Flood Damage:	: 1988, 1991
Repair/rehabilitation in	: Ongoing from 1988

Overview:

A very large FCD project, implemented over a protracted period with Bangladesh internal resources. The Project does not benefit the very important HYV Boro crop in the area, but has resulted in some increase in the area of Aus and in increased adoption and yield of T Aman, both local and HYV. Drainage congestion persists, and sections of the embankment are under constant erosion threat, both due to poor planning. O&M has been very poor. There is still widespread poverty in the area. The Project is marginally viable; EIRR is estimated at 22 per cent, but this is highly sensitive to yield estimates, variations within the range of uncertainty of survey estimates reducing EIRR to 2 per cent.

KURIGRAM SOUTH UNIT

SUMMARY OF FINDINGS

Location

The Kurigram South Project (correctly known as the South Unit of the Kurigram Flood Control and Irrigation Project) is located in the north-west of Bangladesh in the Kurigram and Lalmonirhat Districts, and falls within the FAP North-West Region (see Figure 1.1). The Project area is over 63 000 ha. and is mainly bounded by three major rivers - by the Brahmaputra on the east, by the Teesta on the south and south-west, and by the Dharla on the north-east. The western boundary north of the Teesta is the Kaunia-Mogulhat railway line (see Figure 1.2).

The land is generally highest in the north. It slopes gently down from the north-west to the south-east, and the internal relief is irregular, due to low pockets, gulleys and channels, with low ridges formed by the levees of past river courses.

The control area studied is in the north-western part of the North Unit of the same Project (see Figure 1.3) - this area is open to floods from minor rivers flowing from India, and to some extent from the Dharla River. All other areas in this region have already been protected by embankment projects.

Project Objectives

About 40 per cent of the area used to be flooded annually before the Project, resulting in major damage to Aus and Aman crops, disruption of communication and damage to infrastructure. Large tracts of agricultural land were lost each year due to erosion by the major rivers. Kurigram town was itself threatened by the River Dharla. The Project as implemented aimed to protect the area from flooding by the three major rivers, while at the same time facilitating drainage into the rivers at low river stages.

Project History

A feasibility study for the Kurigram Flood Control and Irrigation Project was carried out in 1971. This recommended a much larger project than the one implemented so far, including flood protection for both north and south units, pumped irrigation from the Dharla for about 30 000 ha. in the north, a diversion barrage on the Dharla River near Kurigram Town to command about 29 000 ha. in the south unit, and tubewell irrigation for a further 20 000 ha. in the south unit. The Project has been implemented over an extended period by BWDB, using local financial resources and FFW. Implementation has concentrated on the flood control and drainage components, and these were substantially complete in the South Unit by 1983/84. Since that date there have continued to be problems due to river erosion, and substantial expenditures have been needed on bank protection works to protect Kurigram town.

In September 1991 the area suffered from serious flooding. This came in from the north-west after the Teesta had overtopped its banks and cut through the Kaunia-Mogulhat railway line.

BWDB continue to plan and prepare for development of the north unit and for irrigation development in the south unit, and in 1991 a Feasibility Study for the latter component was commissioned by JICA.

Construction and Design

The Project as constructed comprises 110 km. of embankment, along the three main rivers, eight main regulators and limited excavation of drainage channels. Standards of construction were acceptable, but the embankments have required frequent rehabilitation following river erosion, and substantial retirement may be necessary in the south following damage in 1991. The embankment in several places crosses sections of the active floodplains of the major rivers, where most of the problems occur, due to river erosion and the use of very sandy floodplain soil for embankments which are then vulnerable to raincuts.

The construction process was spread over a long period, and there appeared to be no procedure for design review in the light of changing river conditions. Moreover, in some places natural drainage channels were blocked by the embankment without any drainage provision, and in general there is inadequate capacity to quickly drain out water during the often short periods in the monsoon when river levels permit gravity drainage (especially from the lowlying south-eastern part of the Project). The Ratna River was never closed off, and hence it flows into the Project freely, but its outfall is a regulator which collapsed in 1988 when flood water in the Ratna breached the embankment. Construction of bank protection works has continued, but these continue to suffer from erosion.

Hydrological Impact

Over the Project as a whole there has been a small reduction in the proportion of lower land categories. Local people reported increased depths and durations of monsoon inundation in the waterlogged south-eastern part of the Project, but the problem was not reflected in PIE data. However, the flashy nature of flooding in the area is not necessarily reflected in normal monsoon water levels.

Irrigation by STW is widespread in both Project and control areas. A slightly higher proportion of Boro is under mechanised irrigation in the Project, possibly reflecting increased security from flooding, since there has been a greater expansion of STW irrigation inside the Project than in the control area in the last 10 years.

Operation and Maintenance

Maintenance of Project infrastructure has been highly inadequate. This is due partly to planning defects and the diversion of scarce resources to expensive protection works for embankments in the active floodplains, and also to high establishment and running costs relative to the amount of active routine O&M undertaken. Funds have been spent on new regulators but not on restoring the intended level of flood protection following the various damages. Cuts and breaches have remained in a state of disrepair for long periods, seriously limiting the potential benefits from the Project. All the drainage channels have now silted up, to a greater or lesser extent, and require re-excavation. Additionally, about two-thirds of the embankment length has homesteads cut into the slopes, further weakening erosion prone reaches of the embankment.

There are conflicts between BWDB and local people over breaches and cuts in the embankment, and over the design and maintenance of regulators. No committees involving local people in O&M have been set up.

Agricultural Impact

The main crops in both the Project area and the control area are TL Aman and HYV Boro, with HYV Aman also important in the northern half of the Project area. The Boro is mainly irrigated by shallow tubewells (STWs). The Project area has a slightly larger area under Boro than the control area, but this is unlikely to be related to the FCD infrastructure as the three main rivers flood after the Boro season.

Cropping intensity is higher in the Project (190 per cent) than the control (174 per cent), largely because of a greater area under jute. There has been a greater move from B Aman to TL Aman, and TL Aman yields are 15 per cent higher in the Project area than in the control. Expenditures on crop inputs are also a little higher in the impacted than in the control area (for both TL Aman and HYV Boro). Reduced flood depths and duration do appear to have had a significant, though not a dramatic impact, on Aus and Aman crops; for example, in 1987 and 1988, yields of the main monsoon crops were substantially higher in the Project than for the same crops in the control area.

Livestock Impact

The impact of the Project on livestock appears to have been minor. The Kurigram area is distinguished by the large holdings of goats and sheep, but these are larger in the control area than in the Project area, as are holdings of bovine animals and of poultry.

Fisheries Impact

Although the Project has had a negative impact on fisheries, this is not as marked as in other FCD project areas. A comparison of Project and control areas indicates that fish catches have fallen in both, but that the declines are greater in the protected area. Fishing effort has been diverted from beels to the less productive rivers, and the blocking of past fish access routes has reduced fishery productivity.

The area is distinguished by a successful fisheries extension effort. The New Fisheries Management Policy is being implemented in the area, NGOs are involved in management of some of the lesser water bodies, deliberate efforts have been made to assist disadvantaged capture fishermen in developing fishponds, and fishpond productivity is exceptionally high - particularly in the protected area. In the Project area, half of the sample fishponds that had been vulnerable to flooding before the Project are still often flooded, but nevertheless the FCD intervention has assisted in promoting culture fisheries.

Infrastructure and Communications

The Project area already had a good road communications network, and while construction of the embankment has further improved this, the impact is not great. The number of boatmen is reported to have fallen in the protected area, but not in the unprotected riverside areas.

The Project infrastructure has complemented the Kurigram town protection works, and has probably reduced flood losses there. But in general it has not increased security from flood damages in rural areas. It was found that in rural areas flooded households in 1988 suffered similar losses in the Project and control areas, although more were affected in the control area. Businesses reported higher damages in the Project, which could have been associated with the timing of the evaluation (which coincided with the exceptional 1991 flood in Kurigram south) or with a tendency for people to invest more at lower land elevations under the impression that these were better protected than they were. It is also a result of the unwise inclusion in the Project of often low-lying tracts of active meander floodplains under constant and fierce erosional attack by the rivers.

Socio-Economic Impact

There appear to be no major differences in occupations or sources of income between Project and control areas, although secondary occupations are more common in the Project. There is no difference in agricultural employment at household level. Although the survey data suggest that the cropping pattern inside the Project implies about one-third more days per hectare are required than in the control area, wage rates in the Project area are slightly lower than in the control area.

There appear to have been negligible Project impacts on secondary economic activities. There has been hardly any growth in numbers of rice mills, input and grain trading enterprises, and light engineering workshops, while the number of oil mills has decreased. The latter, however, is primarily due to the replacement of rabi oilseeds by Boro, and is not a Project effect. It was noted that in the Project area household heads were very likely to have a secondary occupation - far more likely than in the control area. This is usually an indicator of a relatively poor area.

It was also reported that the amount of women's work in farm related activities was declining in this area. A decline in paddy husking, associated with expanded use by men of STW engines for this purpose, is a common phenomenon, but a general decline is not expected and again is an indicator of increasing poverty. Caution must be exercised here, however, since responses may have been coloured by the loss of paddy in the 1991 floods.

Despite these indications, reported incomes were slightly higher (11 per cent) on a per capita basis, but lower on a household basis, in the Project area. However, this may be unreliable, since housing quality, sources of water, sanitary facilities, and food availability all show negligible differences with the control area. Kurigram South was the poorest area surveyed in detail by FAP 12, and the Project has not prevented 80 per cent of households 'partially starving' in the lean period.

Inequality is still extreme (per capita incomes of large landholders are 5.8 times those of the landless) and landholding patterns have not changed relative to the control area.

Local people noted disbenefits to fishermen, boatmen, and the inhabitants of neighbouring areas, and are concerned about declining soil fertility and soil moisture, loss of fisheries and drainage congestion. Land acquisition was a serious problem. Although only 4 per cent of households lost land, in 56 per cent of cases there was no compensation, and compensation was paid only slowly and after payment of bribes.

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Environmental Evaluation

Environmental impacts of the Project itself have not been great, but they vary significantly between different agroecological divisions within the Project area. The higher lands in the north and west are barely affected or unaffected by the Project. The land that used to be moderately flooded in the past has benefited significantly, and there has been a change in cropping patterns as a result. Low lying lands may well be worse off than in pre-Project periods, as drainage congestion has been exacerbated by the embankments. Where tracts of active river floodplain have been included within the embankment, the environmental risk factor is high. Off-site impacts are only minor, as the volumes of water excluded are small compared to the scale of the rivers, and of the Brahmaputra in particular.

Although a number of major environmental changes have taken place in the Project area, these are mainly the result of trends occurring irrespective of the Project and which generally receive only minor and/or localised additional impetus from it. These include the more obvious negative ecological impacts such as retreat of wetlands and the decline of birds, fish and other wildlife; hence, the biotic impact of the Project is almost negligible. Similarly, marked changes in human issues which have been only partially influenced by the Project include the modest increase in agricultural productivity, the decline of capture fisheries and the growing inequity between rich and poor.

Economic Appraisal

Despite the mediocre agricultural performance and prolonged construction period of the Project, it yields an EIRR of about 22 per cent. This is partly due to the absence of large fisheries net disbenefits, since the impact on capture fisheries was small and culture fisheries were benefited and are highly productive. However, the EIRR should be interpreted with great caution. Sensitivity analysis shows that a reduction of 10 per cent in impacted area paddy yield would be sufficient to reduce EIRR below 12 per cent, the assumed opportunity cost of capital, while the PIE survey design was not expected to measure yields to an accuracy of greater than +/- 10 per cent. The Project should therefore be assessed as only marginally viable.

Recommendations

The strategy of trying to protect the low-lying areas from flooding, especially where they are active meander floodplain lands, appears to be very expensive, and not very effective. It may be necessary to revise the approach to FCD infrastructure in the area, maintaining protection to land at medium elevations, where TL Aman and HYV T Aman can be grown, and removing or abandoning the protection attempted for the low-lying areas which at present often suffer from acute drainage congestion or are open to flooding.

Two particular weak spots are currently threatening catastrophic flooding: at Kishorpur Regulator on the Teesta; and at the mouth of the Sanyashil Khal on the Dharla. These require urgent attention.

The proposals to develop a surface irrigation system do not appear justifiable, given the rapid recent expansion of irrigation using groundwater, and should be appraised in comparison with the alternative costs of further promoting STWs, MOSTI and DTWs. Given the poor O&M record it is very unlikely that a major irrigation system would be able to recover even O&M costs, whereas the private irrigation systems cover both O&M and capital costs.

More concentrated effort by DOF and NGOs is justified to capitalise on the gains already made in fish farming and culture based capture fishing in some of the jalmahals, in order to accelerate the process of fisheries expansion.

Given the generally limited environmental impact of the Project as a whole, the need for a future more detailed environmental evaluation (i.e. a Project environmental audit) is less than in many other projects. It would become important if either large-scale surface irrigation were implemented, or large-scale catastrophic flooding took place, since both would have major environmental impacts.

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GLOSSARY AND ABBREVIATIONS

ADB	Asian Development Bank
AED	Agro Ecological Divisions
AER	Agro Ecological Regions
AES	Agro Ecological Subregion
Aman	Main monsoon season paddy crop
Aus	Late dry season/early monsoon paddy crop
BBS	Bangladesh Bureau of Statistics
BCR	Benefit Cost Ratio
BIDS	Bangladesh Institute of Development Studies
BRA	Brahmaputra Riverine Area
BWDB	Bangladesh Water Development Board
cfs	cubic feet per second
DAE	Department of Agricultural Extension
DAU	Draught Animal Units
dheki	wooden husking equipment
DOF	Department of Fisheries
DRA	Dharla Riverine Area
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
EPWAPDA	East Pakistan Water & Power Development Authority
FAO	Food and Agricultural Organisation (of the United Nations)
FAP	Flood Action Plan
FCD	Flood Control and Drainage
FCD/I	Flood Control Drainage/Irrigation
FDR	Flood Damage Repair
FFW	Food for Works
FPCO	Flood Plan Coordination Organisation
HH	Household
HTW	hand tubewell
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
MOSTI	Manually Operated Shallow Tubewell for Irrigation
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
PP	Project Proforma

PPS	Probability Proportional to Size
rabi	winter cropping season
RDRS	Rangpur Dinajpur Rural Services
R&H	Roads and Highways
RRA	Rapid Rural Appraisal
SCF	Specific Conversion Factor
SRS	Simple Random Sampling
STW	Shallow Tube-well (with suction pump)
Tk.	Taka
TMFP	Teesta Meander Floodplain
TRA	Teesta Riverine Area
UFO	Upazila Fisheries Officer
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 National Flood Action Plan, and is jointly supported by the United Kingdom Overseas Development Administration (ODA) and the Japan International Cooperation Agency (JICA). It is being 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 the Kurigram Flood Control and Irrigation Project South Unit (Kurigram South).

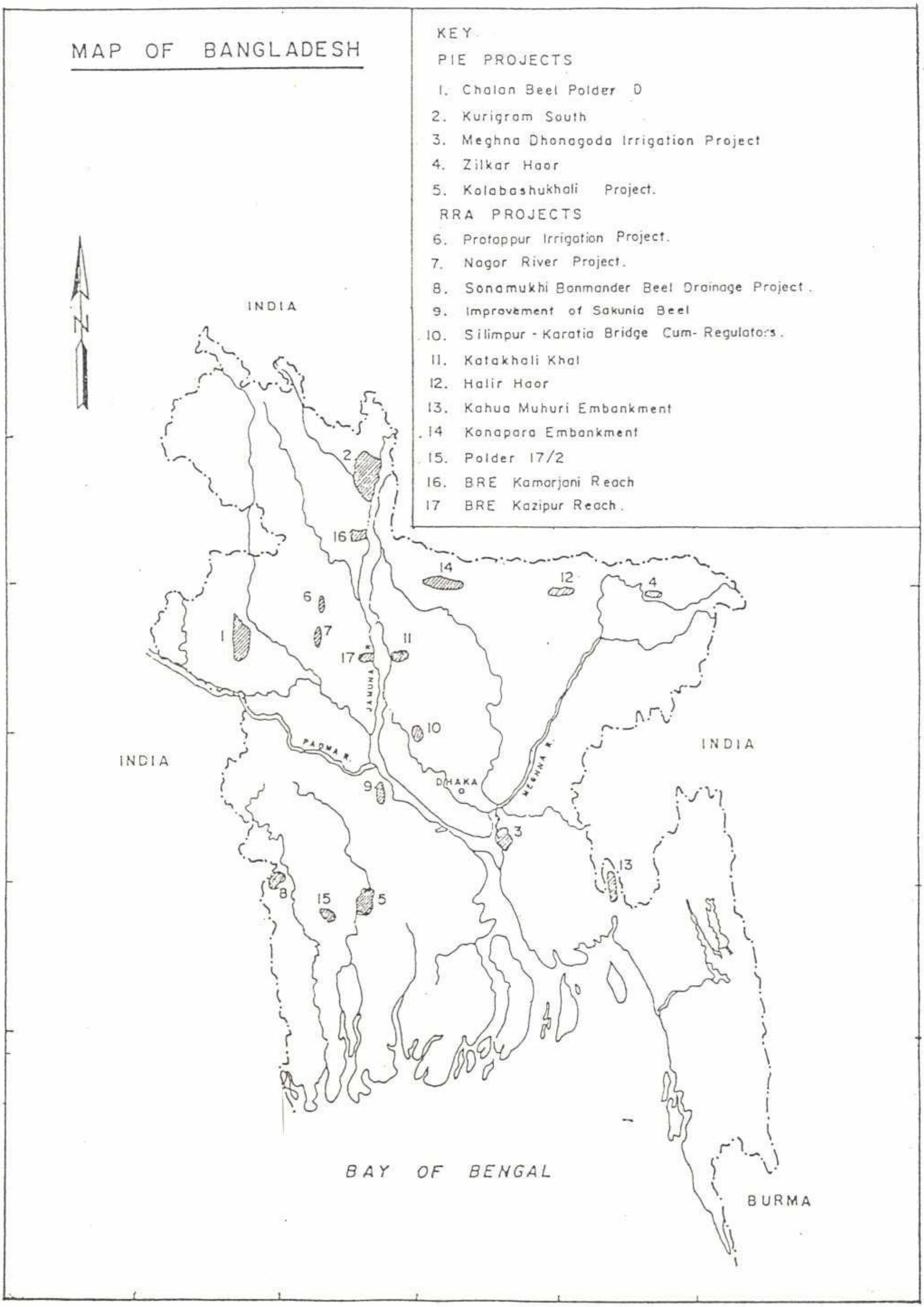
1.2 PROJECT DESCRIPTION

1.2.1 Location

Kurigram South is situated in the Upazilas of Kurigram, Lalmonirhat, Ulipur, Chilmari and Rajarhat of Kurigram and Lalmonirhat Districts, and is adjacent to the northern border with India (Figure 1.1). It falls within the Flood Action Plan's North-West Region and is under the Kurigram implementation division of BWDB (although non-project structures fall under Dinajpur Operation and Maintenance (O&M) Division). The Project has a gross area of 63,765 ha and a net cultivable area of 50,000 ha. The Project area is mainly bounded by three major rivers: by the Brahmaputra on the east, by the Teesta on the south and south-west, and by the Dharla on the north-east. The western boundary north of the Teesta is the Kaunia-Moghulhat railway line (Figure 1.2).

The control area (see Section 1.3.2 for methodology) studied is in the north-western part of the North Unit of the Kurigram Project (Figure 1.3). This area is open to floods from minor rivers flowing from India, and to some extent from the Dharla River. All other areas in this region have already been protected by embankment projects.

Figure 1.1 Location of Selected PIE and RRA Projects



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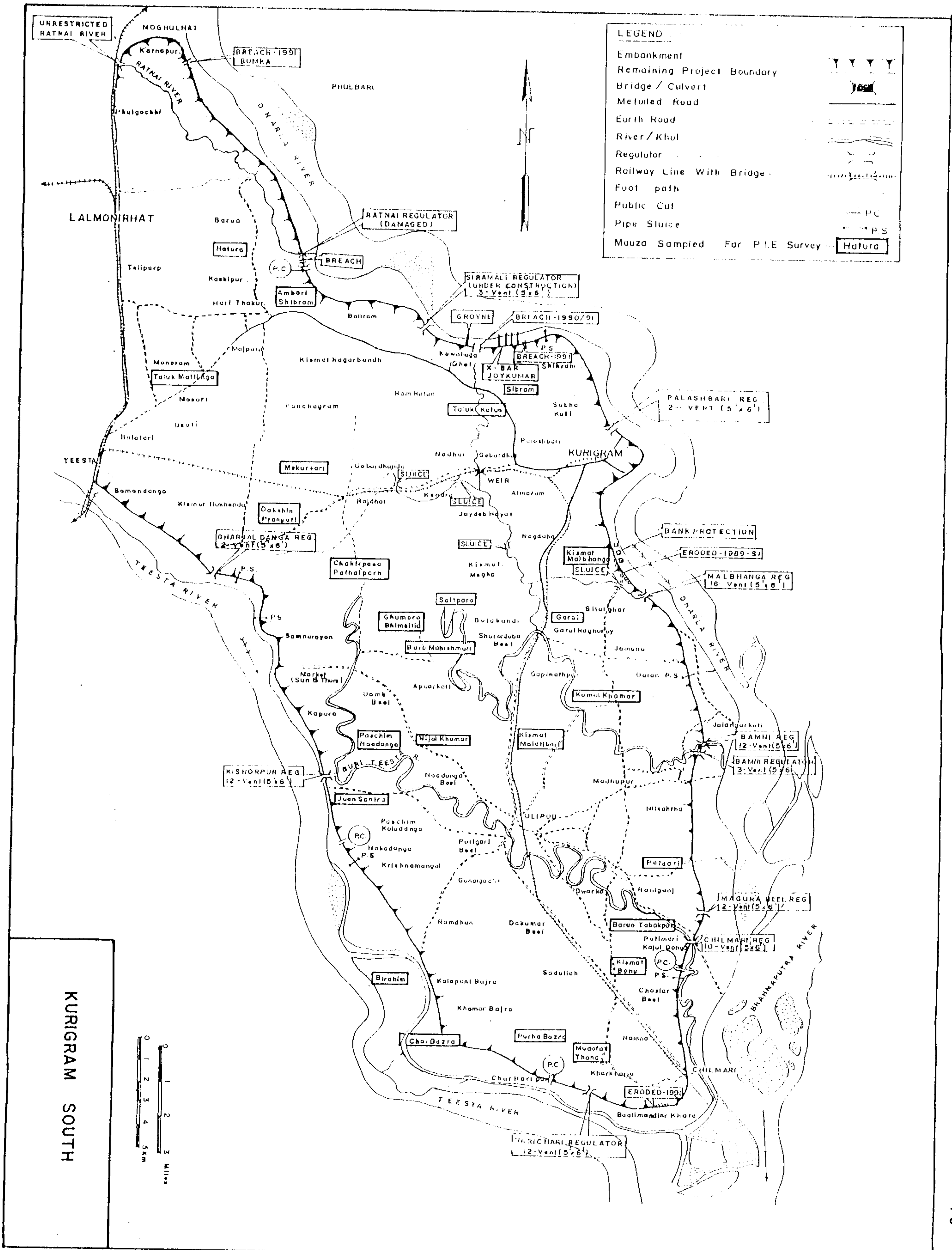

Figure 1.2 Kurigram South Impacted Area Map

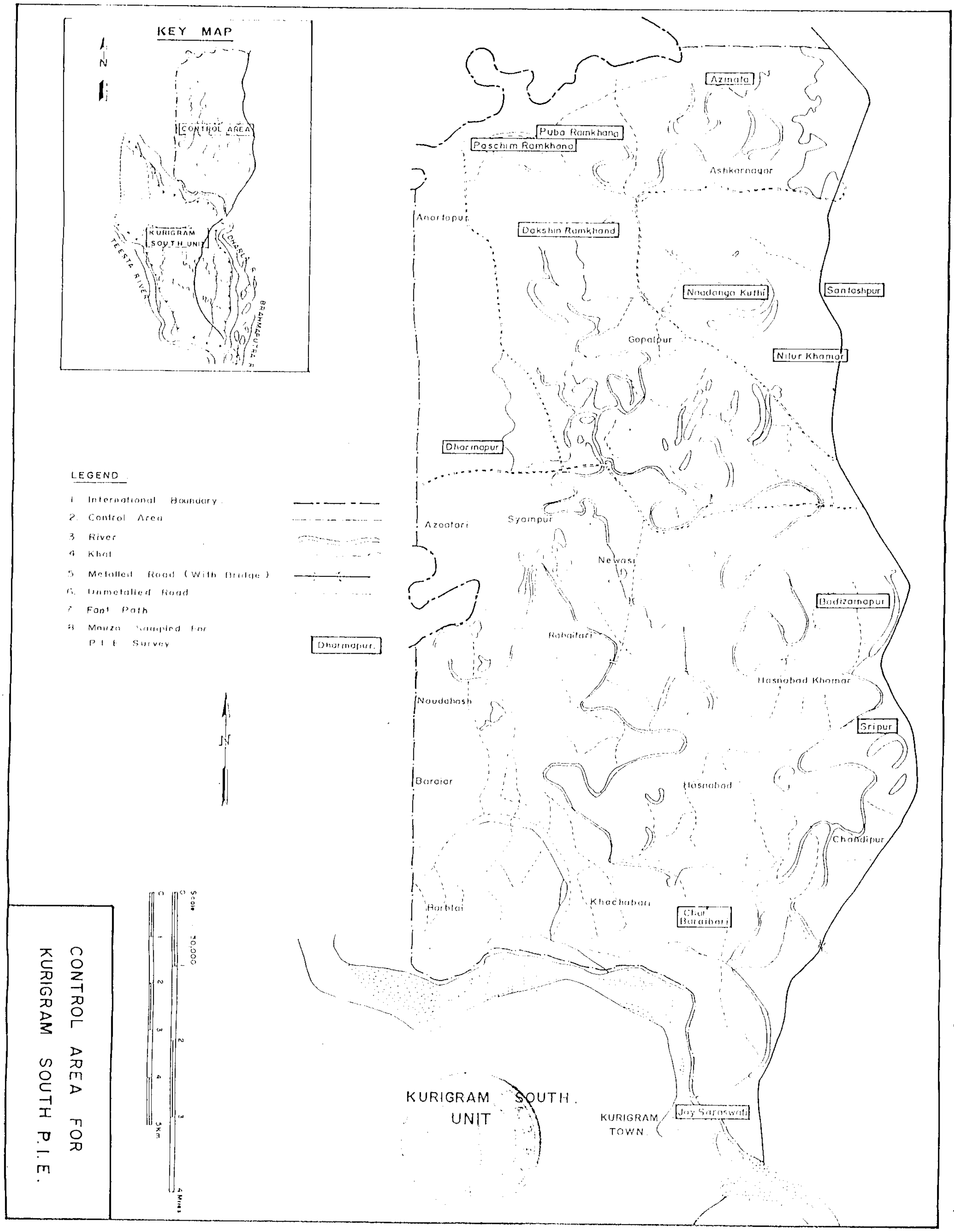

Figure 1.3 Kurigram South Control Area Map

1.2.2 Physical Characteristics

The physical characteristics of the Project area are largely determined by its location at the confluence of the Teesta and Dharla rivers with the large Brahmaputra River. The land is generally highest in the north and lower in the south with elevations of 22-34m (70-110 feet) above PWD (Techno Consult, 1971). It slopes gently down with a gradient of about one foot per mile (equivalent to 1:5300) from north-west to south-east. There are occasional undulations with irregular relief due to low pockets. Erosion by the Dharla, Brahmaputra and Teesta used to be a major pre-project problem, a tendency that is still retained.

Mean annual rainfall is just over 2500 mm per year, but shows considerable variability (minimum 1235 mm 1972-73; maximum 3000 mm 1949). Pre-project about 40 per cent of the area was regularly flooded, but other parts of the area were relatively high, and the sandy nature of soils in much of the area resulted in soil moisture deficit for rabi crops. Cropping was varied, with the main paddy crop T Aman; and Aus and rabi crops widespread but dependent on moisture availability.

1.2.3 Outline of Project Design and Objectives

The planned surface irrigation system was never implemented and so Kurigram South is a Flood Control and Drainage (FCD) project, and was selected for evaluation as representative of FCD projects with embankments along the major river systems. The main design features are an embankment along the Teesta, Brahmaputra and Dharla rivers which joins the Kaunia-Mogulhat railway embankment to the north-west. Drainage is provided by the old river courses, such as the Buri Teesta, within the Project, by the existing khal network, and through eight main regulators (with other supplementary regulators under construction in 1991). It was proposed to build a barrage on the Dharla River and to supply water to the Project area through gravity flow canals to lower areas, with a pumping plant to supply water to the higher land. However, this has never been built, although it is again (1992) under consideration for a new feasibility study.

The objectives of the Project were to protect the Project interior from river flooding, and to alleviate drainage congestion during the monsoon thus T Aman yields would be more secure. Irrigation was expected to result in increased rabi crop intensities and the cultivation of T Aus instead of B. Aus (Techno Consult, 1971).

1.2.4 Project History

As with most major FCD/I projects in Bangladesh, Kurigram South was originally identified in the East Pakistan Water And Power Development Authority (EPWAPDA) Master Plan (EPWAPDA, 1964) portfolio of projects. A feasibility study was carried out by Pakistan Techno Consult Ltd during 1969-71 (Techno Consult, 1971) for improved FCDI for the area. There were very few lengths of embankment in the Project area at that time, but a number of attempts to reduce erosion problems had been made in the 1950s and 1960s (Techno Consult, 1971). Construction by the Bangladesh Water Development Board (BWDB) started in 1973-74, and the Project was effectively completed in its current form (embankment plus main regulators) in 1983-84. Resources for the Project appear always to have been a problem and much of the embankment has been built and repaired under Food For Work (FFW) programmes.

Ever since completion there has been a continual erosion problem along all three rivers bordering the Project, and as a result there have been a number of erosion breaches in the embankment. There has also been a programme of bank protection and river training works (such as cross bars and groynes) to protect both Kurigram Town and the embankment. Following a series of breaches and public cuts during the 1987-88 period, the project has received funds under one of the Flood Damage Repair projects to construct three more regulators in an attempt to reduce drainage problems. However, in 1991 there were still a number of gaps in the embankment, and the drainage system had never been re-excavated.

The Project is regarded as ongoing, a revised Project Proforma was developed in 1987 (BWDB, 1987b), along with TOR for a new feasibility study (BWDB, 1987a).

1.3 METHODOLOGY

1.3.1 Previous Appraisals and 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 Kurigram South, no previous post-evaluation had been made. The Project was regarded as complete for the purposes of this study since it has been completed in its FCD components since 1983-84 (even though it has not been declared complete by BWDB). The only primary data available was from the four volume Feasibility Study (Techno Consult, 1971).

1.3.2 RRA and PIE Surveys

FAP 12's methodology for project evaluation has been described in detail in the FAP 12 Methodology Report (FAP12, 1991) and the experience with its application in practice has been reviewed in the FAP 12 Final Report (FAP12, 1992). 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 and maintenance data with observations during the high water period.

1.3.3 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. In the case of Kurigram South the potential control areas were limited to uncompleted parts of the Kurigram North Unit and, as Chapter 3 shows, there were some hydrological differences between the two areas. The Project area was defined as the Project impacted area for the purpose of sampling, and hence included, in the case of Kurigram South, a band of villages in the active flood plains which could have been impacted by the embankment.

b) Probability Samples

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 non-cultivators (almost exclusively landless labour households in practice). 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 Atlas 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, 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 as 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 Kurigram South

The preliminary RRA of Kurigram South was conducted in April 1991 by a multidisciplinary team consisting of an agricultural economist (team leader), an agriculturalists, a civil engineer, a sociologist/rural institutions specialist, a nutritionist, and an environmentalist. Subsequent visits were made by FAP 12/13 engineers and institutions specialists in September 1991 to collect additional data on the hydrology and O&M of the Project and on the Project's construction, rehabilitation and operating costs; and by two environmentalists in November 1991 to make a more intensive Preliminary Environmental Post-Evaluation (PEP).

The PIE of Kurigram South was conducted during September 1991, following the methodology described in Section 1.3.2 above. The control area selected for comparison with the Project area is the north-western part of the Kurigram North Unit comprising most of Nageswari Upazila and parts of Phulbari and Kurigram Upazilas. The North Unit is not yet complete (in a physical sense). The control area is open to flooding from India to the north, and to a lesser extent from the Dharla. The remaining nearby areas along the main rivers have all been embanked. Cropping patterns in the control area are closely comparable with the Project area, although some differences in hydrology.

In the impacted area a total of 120 cultivating and 48 labour households were sampled in 24 clusters, falling in 24 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 Kurigram 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 District Commissioner, Kurigram, and the officials of Kurigram and Lalmonirhat Districts and of Kurigram, Ulipur, Rajahat, Chilmari, Lalmonirhat, Phulbari and Nageswari Upazilas, to the Superintending Engineer and staff of the BWDB Kurigram Circle, to the Chairmen and Members of the Union Parishads in the survey areas, and to the staff of Rangpur-Dinajpur Rural Services. 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.

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2 PLANNING, DESIGN AND CONSTRUCTION

2.1 THE PHYSICAL AND HYDROLOGICAL SETTING

2.1.1 Location and Physical Characteristics

The Kurigram Flood Control and Irrigation Project - South Unit (Kurigram South) is located in the Kurigram and Lalmonirhat Districts adjacent to the northern international boundary with India. The Project area has a diamond-shaped boundary formed to the north-east by the Dharla river, to the east by the Brahmaputra river, to the south-east by the Teesta river and to the west by the Kaunia-Moghulhat railway line. The physical features of the area are directly related to these river regimes. The land has a gentle slope and the elevation varies from 22-34m (110-70 feet) PWD. There are occasional undulations with irregular relief due to low pockets, gulleys and depressions which is typical of the land formation process along the major rivers.

The Brahmaputra River which forms the eastern fringe of the Project area is the largest river in the sub-continent. It has a large number of tributaries, of which the Teesta, the Dharla and the Dudhkumar are the most important in Bangladesh. It has an annual discharge of between 130,000 cfs and 2,300,000 cfs. The Brahmaputra, Teesta and Dharla serve to drain the Project area. They are characterised by unstable beds and banks, with the channels and shoals tending to change continuously. During the monsoon about 40 per cent of the area was flooded almost every year resulting in extensive damage to Aus and Aman crops (pre-project), disruption of communication and other infrastructures.

The rivers in the vicinity of the Project area change their course due to bank erosion and movement of river bed. Efforts were made after flooding in the 1950s to prevent erosion by the Dharla river at several places. None of the many attempts since then have proved to be fully satisfactory.

Irrigation before the Project was started (pre-1970) was very limited. Small areas near to khals were irrigated during the rabi and early Aman seasons, and high rabi crop yields were obtained. However, there was little scope to expand this area by local means.

2.1.2 Hydrology and Flood Types

Figures 2.1 and 2.2 comprise pre-project "normal year" hydrographs from 1981-82 and 1983-84 respectively for the Brahmaputra River at Chilmari (gauging station 45/5), the Dharla River at Kurigram (gauging station 77) and the Teesta River at Kaunia (gauging station 294). It is notable that the hydrographs for Kaunia and Kurigram show much less annual variation in level than that at Chilmari because these tributaries have less run-off per river width than the Brahmaputra. Also the Teesta in particular shows a tendency for earlier flash floods at the end of June.

Figure 2.1 WATER LEVEL RECORD (I) (KS-1981/82)

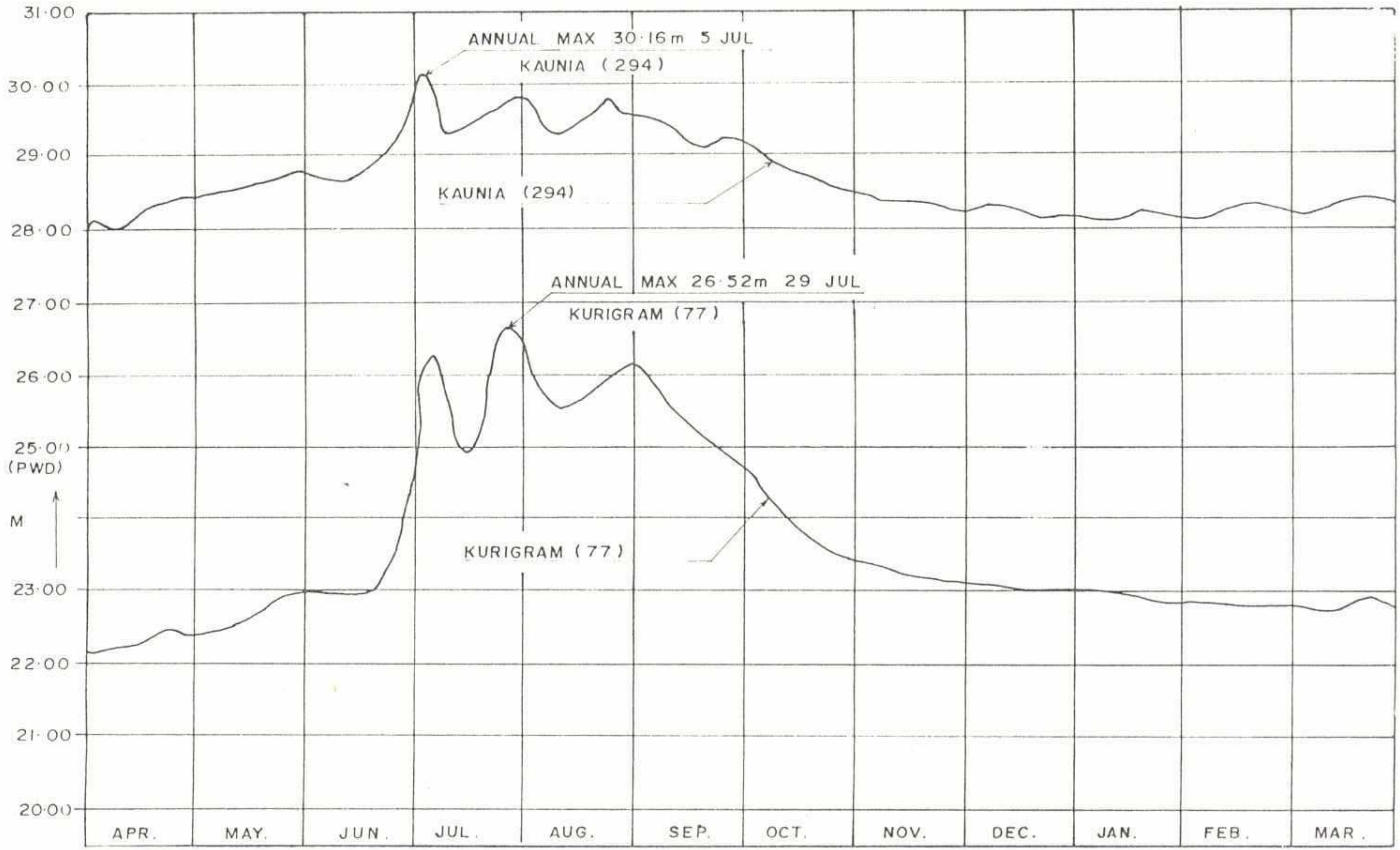
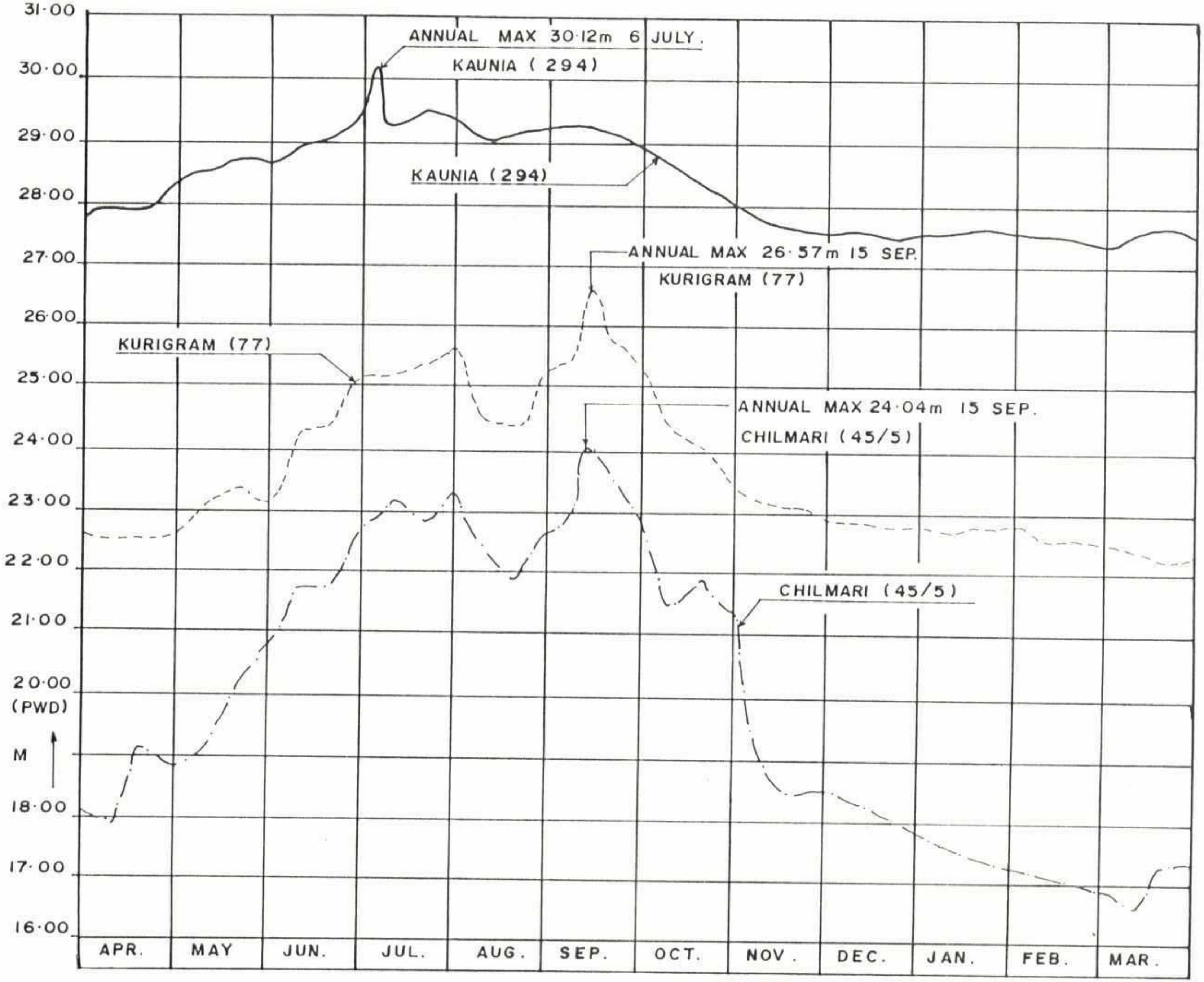


Figure 2.2 WATER LEVEL RECORD (2) (KS - 1983/84)



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Hence the hydrographs indicate that the hydrology of the Kurigram South Unit, located along the upstream reach of the Brahmaputra River within Bangladesh, can be categorised as falling into Flood Type M (Monsoon flood along main river) in the classification adopted by FAP 12 (FAP 12 Final Report, Volume 1, Section 3.4.1). However, the hydrology also shows characteristics of Flood Type F (Flash floods) along the Dharla River and the Teesta River. Flood peaks are typically in the period late June to late September.

2.2 PROJECT OBJECTIVES AND DESIGN

The stated technical objectives of the Project (Techno Consult, 1971; p VI-1) were:

- to guarantee freedom from recurrent inundation of cropped land by river water during the monsoon;

- to provide economically viable drainage facility for the runoff generated within the protected area by direct rainfall; and

- to supply water adequate for irrigation according to the requirement of the proposed crops.

Hence the primary objective of the Project was to effect an improvement in the water regime to facilitate crop production. The Project was intended to provide flood control and drainage to 25,506 ha and irrigation to 49,000 ha out of a net cultivated area of some 49,000 ha (BWDB, 1987b). The Project area was to be protected from spilling of the rivers by construction of an embankment along the right bank of the Brahmaputra, the left bank of the Teesta and the right bank of the Dharla.

For the drainage of internal runoff during the monsoon, existing channels were to be developed into an efficient drainage system. The Feasibility Study (Techno Consult, 1971) indicated that five drainage sluices (regulators) were originally planned at Ratnai, Malbhanga, Chilmari, Harichari and Kishorpur to drain out internal rainfall through the embankment into the rivers.

For the irrigation of the area, the Dharla river was proposed to be headed up by a Barrage pool. Gravity canals would carry and distribute irrigation water. In order to irrigate areas outside the command of the Barrage (because of their higher elevation), a pumping plant was proposed on the right bank of the Dharla river. Out of the planned total irrigated area of 49,000 ha, about 28,200 ha of the area was proposed to be irrigated by the Barrage and 20,800 ha was to be irrigated by the pumping plant.

2.3 PROJECT AS IMPLEMENTED

Table 2.1 details the Project infrastructure planned and implemented and its intended design parameters. Due to poor documentation it is not possible to determine the reasons for variations between the Feasibility Study and Project as implemented, for example the revised PP (BWDB, 1987b) does not make it clear what had been completed up to that date, how it differed from previous plans, or how it was funded. However, from the Feasibility Study (Techno Consult, 1971) it is clear that the consultants were aware of several planning issues which reappear as problems in the evaluation of the Project.

Table 2.1 Engineering and Hydrology Summary (Kurigram South Unit)

Project Type	:	Flood Control and Drainage
Project Area	:	63,765 ha. (gross) c49,000 ha (net cultivable)
Construction Period	:	1975/76-1983/84 (afterward major new work suspended)
Embankment Length	:	103 km.
Crest Width	:	14 ft
Side Slope	:	Intended R/S 1:3, C/S 1:3-1:4; Actual R/S 1:3, C/S 1:2
Berm Width	:	R/S variable, C/S 1.5 m.
Setback Distance	:	not specified, but supposed to be at least 60m.
Crest Elevation	:	25.05 - 31.39 m. PWD
Free Board	:	3-5 ft (0.9-1.6 m.)
Design Flood	:	1-in-100 years return period
Pumping Plant (not implemented)	:	1 No. (14.2 cusec x 4 pumps)
Irrigation System (not implemented)	:	No. of irrigation unit 2 Nos. Length of main canal 63 km. Length of branch canal 70 km. Length of side canal 205 km.
Dharla Barrage (not implemented)	:	1 No. (Length 569 m. No. of gate 31 nos.)
Drainage System	:	192.6 km. (actual re-excavation unclear)
Regulator	:	Planned (1971): 5 no. with 96 vents Constructed by 1983-84: 8 no. with 74 vents Under construction (1991): 3 no. with 8 vents
Bridge & Culvert	:	37 Nos.
Water Level Record	:	Kurigram (77) Kaunia (294) Chilmari (45/5)
Major Flood Damage	:	1988, 1991 Continued erosion problem - bank protection works 1987/88-1991.
Normal Flood Years	:	1981, 1983
Above Normal Flood Years	:	1987, 1988

Source : Techno Consult (1971), Consultant's field investigations

Specifically the Feasibility Study noted that the Ratnai river originates outside the Project, but regarded it as not posing a threat because of its small catchment of under 5000 ha (Techno Consult, 1971). The long history of erosion along the main rivers in this area was noted, and it was proposed that a special study of erosion and the embankment alignment should be made, although it is not clear that this was undertaken. Also the Feasibility Study recognised that major embankments (both Kurigram South and the nearby Brahmaputra and Teesta embankment projects) may affect one another (Techno Consult, 1971). It was reported that the confinement effect of the combination of projects had been taken into account, and that only on part of the Teesta right embankment would the embankment need to be raised because of the Kurigram Project. However, there was no discussion or assessment of the potential impacts on the areas not protected by these projects.

2.4 REASSESSMENT OF PROJECT

2.4.1 Flood Protection Design Standard

Preliminary water level analysis has been conducted comparing the observed water level data at Chilmari (45/5), Kurigram (77) and Kaunia (294) with the embankment crest elevation as recorded in a BWDB survey during 1991. Annex A gives details of the annual water level records for the three gauging stations (Tables A.1-A.3), and a probability analysis of this data for extreme values using Gumbel's formula (Tables A.4-A.6). This is limited by the lack of records available for recent years, including 1987 and 1988 which were exceptional flood years in Bangladesh in general, which may affect the probability analysis.

Table 2.2 gives details of the embankment crest elevation as surveyed by BWDB during the 1991 monsoon. As will be seen at the regulator sites the actual crest elevation averages 0.72 m below the design level and is only up to the design level at one site (Gharialdhanga). By comparing the results of the probability analysis with the embankment design and actual standard at those sites close to the gauging stations an approximate assessment of the Project design and the standard of protection afforded by the Project can be made. However, it has not been possible under FAP 12 to make a detailed assessment for the whole of the embankment, which would obviously be a high priority for studies of future investments in the Project.

Table 2.3 shows that for the highest floods in the available record the embankment (actual 1991 elevation) did have sufficient freeboard, although at Kaunia station the freeboard was just sufficient. Likewise the results of the probability analysis in Appendix A indicate that the embankment even in its present state of maintenance has sufficient freeboard at the regulator sites, except at Gharialdhanga, compared with the reassessed 1-in-100 year design flood standard. However, it should be noted that there are many points along the embankment away from the regulators where the relative crest elevation is lower or the embankment is breached.

Table 2.2 **Embankment Crest Elevation (Kurigram South)**

Name of Regulator	Embankment Crest El. (m PWD) at Regulator		W.L. Station Nearby
	Design El.	Existing El.	
1. Ratnai Regulator	32.35	31.38	
2. Siramali Regulator	31.10	30.25	
3. Palashbari Regulator	29.50	28.80	Kurigram(77)
4. Malbanga Regulator	28.26	27.70	
5. Bamni Regulator	27.40	26.92	
6. Magura Beel Regulator	27.40	25.05	
7. Chilmari Regulator	27.40	26.12	Chilmari(45/5)
8. Harichari Regulator	26.68	26.50	Chilmari(45/5)
9. Kishorpur Regulator	28.39	28.13	
10.Gharialdhanga Regulator	31.39	31.39	Kaunia(294)

Source : BWDB Kurigram Sub-Division-1

Table 2.3 Reassessment of Embankment Freeboard at Regulator Sites
(Elevation in m-PWD)

Name of Reg.	Crest El. (1)	Observed W.L. (2)	Recorded Freeboard (3)=(1)-(2)	1-in-100 W.L. (4)	Allowance (5)=(1)-(4)
Palashbari	28.80	Kurigram(77) 27.33(1984)	1.47 m	27.54	1.26 m
Chilmari	26.12	Chilmari(45/5) 24.46(1974)	1.66 m	24.88	1.24 m
Harichari	26.50	Chilmari(45/5) 24.46(1974)	2.04 m	24.88	1.62 m
Gharialdhanga	31.39	Kaunia(294) 30.45(1968)	0.94 m	30.80	0.59 m

Source: Table 2.2 and Appendix A Tables A.1-A.6.

2.4.2 Present Condition of Embankment

The Project comprises about 110 km. of embankment according to BWDB project documents but there are a number of openings (cuts and breaches). Although the embankment is tied into the railway embankment in the north-west, there are openings in this, and in 1991 the railway was overtopped, indicating that the standard of protection afforded by the railway line should be assessed. A number of operation and maintenance (O&M) problems are apparent in the Project, and further details are given in Chapter 4. However, in many cases these are symptoms of problems in the original planning, design and construction of the Project, and these are discussed briefly in this section.

a) Rain Cuts

There are many serious rain cuts along the embankment, particularly the length between the 2-vent Raniganj regulator and the 16-vent Malbhanga regulator. These raincuts are due to the cohesionless materials (sand and silt) used in building the embankment, and hence indicate problems in the detailed design and construction phase.

b) Public Cuts

A number of public cuts have been made in Kurigram South embankment during recent years, those still open in September 1991 are:

- 30 m long cut at Hokodanga;
- 46 m cut at Haripur made in 1990;
- 46 m cut at Chaslar beel made in 1988; and
- 38 m cut near the breach at the Ratnai regulator dating to 1988.

Public cuts had been a frequent response to drainage problems when the interior water levels rose higher than outside river stages. These public cuts have remained unrepaired for several years after their occurrence. Further details are given in Section 4.3.1.

c) Erosion and Breaches

Erosion of several reaches of the embankment is a serious threat to the protected area. It is apparent that the embankment was built within the active flood plains of the three rivers in several places. This has resulted in persistent problems and a high expenditure on embankment protection and river training works, which might have been avoided by locating the embankment further away from the rivers.

In 1991 about 150m (500 ft) of flood embankment near the Malbhanga regulator was breached and another 460m (1500 ft) next to this portion is rapidly eroding. An attempt to embank the 150m breached portion was ongoing in September 1991 but was yet to be completed. Just upstream of this erosion BWDB has been protecting the embankment with concrete blocks, but the erosion continues.

About 250m (830 ft) of the flood embankment a little down stream of the "Joykumar project" (four cross-bars constructed to deflect erosion and avoid a breach) was severely eroded by the current of Dharla river in mid-1991. BWDB, Kurigram, has completed resectioning works on the eroding embankment, this together with the remaining undamaged one-third portion might well fail in 1992.

Near Chilmari ferry terminal erosion has been continuing in recent years, during 1991 the river bank moved about 90m (300 ft) in towards the embankment, as a result perhaps one mile of embankment has either eroded completely or has only the countryside slope left. The embankment erosion is also displacing people who had taken shelter on the embankment when their previous homesteads were eroded. BWDB expects that the brick and earth roads from the ferry ghat to Harichari regulator will act as a retired embankment for the moment, but plans a substantially retired embankment which would abandon the areas flooded by this breach in 1991.

Near the Kawahaga ghat there are two adjacent breaches totalling about 460m (1500 ft). One occurred in 1989 and was closed off by a retired embankment in the same year. In 1990 another breach (erosion) took place together with the erosion of the previous year's retired embankment. BWDB tried to construct a retired embankment, but did not complete it. In an attempt to protect the above-mentioned breached areas BWDB has completed in 1991 construction of a groyne in Kawahaga ghat.

e) Housing on the Embankment

Much of the embankment has been occupied by housing, and the O&M problems associated with this are discussed in Section 4.4.1.

2.4.3 Water Control Structures

Table 2.4 details the water control structures found by the FAP 12 team in the Project embankment, but not additional structures located within the Project area, locations are shown on Figure 1.2. The Project consists of 11 regulators with ventages between 2 and 16, there are also 4 non-Project 1-vent pipe sluices in the embankment. The conditions of these structures are shown in Table 2.4. In general, the regulators are in good condition, although some repairs to gates, replacement of gate seals etc. are required. In a few cases both the river side and country side loose aprons are in very poor condition and need immediate repair. In case of Kishorpur regulator erosion of the riverside guide bund in 1991 by the Teesta has threatened the regulator itself. The operation and status of the non-Project structures is discussed in Section 4.3.2.

Table 2.4 Summary of Condition of Main Drainage Structures in Kurigram South Unit

Type and Location of Structure	Present condition of structure										Present Condition of Drainage Channel	
	Regulator/Sluice								Gate		Need re-excavation (km)	
	No. of Ventage	Gate	Wing wall C/S	Wing wall R/S	Box	Apron C/S	Apron R/S		Gate	Rubber Seal/ Groove	C/S	R/S
Gharial Danga Regulator	2	V.L.	G	G	G	F	F		G	R.S to be provided	F	F
Kishorepur Regulator	12	V.L.	G	G	G	F	F		G	R.S to be provided	F	P
Harichari Regulator	12	V.L.	G	G	G	G	G		G	Nil		
Chasler Beel Pipe Sluice [a]	1	F.B.	P	P	F	P	P		-	-	-	-
Chilmari Regulator	10	V.L.	G	G	F*	G	G		G	-	G	G
Raniganj Pipe Sluice[a]	1	F.B.	P	P	F	P	P		-	-		
Raniganj Regulator[b]	2	V.L.	G	G	G	G	G		1 G, Other not installed	Nil	-	-
Bamni Regulator (additional) [b]	3	V.L.	G	G	G	G	G		V.L. not yet installed, Closed by F.B.	N/A	-	-
Bamni Regulator (main)	12	V.L.	G	G	G	G	G		G, 1 not operating	Nil	G	G
Dalan Pipe Sluice[a]	1	F.B.	P	P	F	P	P		damaged	-		
Malbhanga Regulator	16	V.L.	G	G	G	G	G		13 G, 3 not operating	Nil	G	G
Palashbari Regulator	2	V.L.	G	G	G	G	G		G	Provided		
Char Modajalfara Pipe Sluice[a]	1	F.G.	G	G	G	G	G		G	Provided	-	Needed
Siramali Regulator[b]	3	V.L.	Not yet completed									
Ratnai Regulator	8	V.L.	Collapsed due to public cut - now a breach on both sides									

* Minor Crack in Vertical Wall
[a] not listed in project infrastructure
[b] built in 1991, remaining sluices date from 1970s.

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

2.4.4 Channels/Canals

According to the original plan 192.62 km of drainage channel were planned (irrigation is ignored here). In reality the executed length appears to have been much less than that planned. Drainage improvement is a prime requirement of the Project, and some operating problems relating to drainage and public cuts are discussed in detail in Section 4.3.1

All the natural drainage channels and rivers which feed the regulators of the Project have become silted up. It is not clear whether BWDB ever developed a drainage plan for the Project as implemented, or rationalised the channels (as some of them are very meandering - for example there are ox-bows adjacent to the country side of the embankment) or did any re-excavation. The drainage system should be reassessed to overcome the present drainage problems.

2.5 IRRIGATION ASPECTS

The original planning the Project had an ambitious programme for surface irrigation, and many irrigation structures and a network of canal works were planned (Table 2.1). However, work on the irrigation component has not actually started. Were this taken up now the implementation of the whole programme would imply a 20+ year period, during which the agricultural system has changed considerably (see Chapter 5). Hence, any future work on Kurigram South should be seen as a separate project. There are a number of reasons for thinking that the irrigation component would not be viable, these have mostly been stated already in FAO (1988):

i. The Project area has a sandy substrata implying that seepage losses from major irrigation distributaries would be high, and water demand might be high.

ii. Farmers already grow good rabi and early kharif crops on residual moisture, so the original objective of the irrigation system may be misplaced.

iii. Surface irrigation for HYV Boro might adversely affect waterlogging and soil fertility.

iv. Groundwater is available at a shallow depth and there has been considerable expansion of STW and DTW irrigation since the original Project plan in 1971, reducing the area which would benefit from surface irrigation.

v. Small scale irrigation is easier to manage - in terms of water management and system O&M.

vi. Cost recovery is virtually non-existent in BWDB main irrigation systems compared with private irrigation, so surface irrigation is unlikely to be sustainable.

vii. The region is prone to earthquakes which would be a risk for large structures like a barrage.

As will be apparent from this chapter, higher priorities in making the existing system more effective are to improve embankment maintenance, effect speedy retirement of embankments threatened by erosion, and to improve drainage. Careful re-assessment of the proposed irrigation components is needed before any new investments are made in this sector.

2.6 RECOMMENDATIONS

2.6.1 Development and Rehabilitation of Kurigram South

i. All the natural drainage channels and rivers which feed the regulators have become silted up. It is not clear whether BWDB ever developed a drainage plan for the Project as implemented, or rationalised the channels (some are very meandering, in some places ox-bows are adjacent to the embankment), or did any re-excavation. The drainage system should be re-assessed and drainage and flood problems throughout the Project mapped and quantified so that priorities for drainage improvement can be set. FFW appears not to have been used for drainage improvements in 1989-91.

ii. The embankment at Ratnai needs to be re-aligned and straightened and linked up to the railway line. This appears to be a design fault, resulting in greater water logging in the area.

iii. The planned Dharla Barrage and the pumping plant at Bumka should be abandoned. The original plan was to provide irrigation by gravity flow, basically for the Aman crop. While supplementary irrigation for Aman is indeed desirable, it is unlikely to be cost effective purely on this ground. Further, the command area of around 36,500 ha. is too small to justify the huge capital expenditure that will be required (around Tk. 250 crores). Minor irrigation, on the other hand has expanded rapidly, and this trend should instead be encouraged.

iv. Maps available with BWDB are broadly out of date, and fail to clearly indicate the state and location of different water bodies. They should be updated before any detailed revisions to the Project.

v. Large works need to be carefully monitored and reviewed, and even terminated mid-way, when the need for them is no longer urgent, and priorities reordered towards repairs and rehabilitation of the existing infrastructure, and then to routine maintenance. As an example, a cross-bar was being constructed on the Teesta in April 1991, although the river had moved far away and no longer posed a threat to the Project. At the time of initiation of the work, the threat was of course real.

vi. A programme to rehabilitate the embankment is needed, but should aim to rectify local negative impacts on drainage and floods inside and outside the embankment at the same time.

2.6.2 General Recommendations for FCD/I Projects

i. It is essential to have a minimum period of development after completion before commissioning a Project, to allow time to fine tune and trouble shoot for problems. Its absence has led to numerous teething problems (eg. drainage congestion and public cuts) and a rapid degeneration of works.

ii. Project planning should avoid building embankments in active floodplains: the soils are less suited to construction, the risk of erosion is high, the costs of bank protection are high, and it gives those behind the embankment a false sense of security.

iii. More attention should be paid to drainage planning and the suggestions of Feasibility Studies when implementing projects.

iv. Dues arising from land acquisition should be settled promptly to avoid conflicts.

v. Prioritisation in correcting problems such as breaches and cuts needs to be improved. Many cuts and breaches have remained open for several years, reducing Project benefits, while the expenditure on protection for embankments may be much more costly than retiring the embankment to a safer location.

3 HYDROLOGICAL IMPACT

3.1 INTRODUCTION

The pre-project hydrology of the Project area has been discussed in Chapter 2 along with the objectives of the Project. In the pre-project situation, the rivers Brahmaputra, Teesta and Dharla overflowed their banks and inundated large portions of the Project area during the flood season. High stage in these rivers also blocked drainage of the run off generated by rainfall inside the Project area. Extensive damages to Aus, Aman and jute crops were caused every year, affecting the regional economy. Although specific water level targets were not set, the Feasibility Study expected that external floods would be kept out of the area and that drainage would be improved. The surface irrigation component of the Project was not implemented, but this Chapter assesses changes in irrigation which have in any case taken place.

3.2 SOURCES OF DATA COLLECTED

The following reports and Project documents were reviewed in connection with the Project study:

- Kurigram Flood Control and Irrigation Project Feasibility Study (Techno Consult Eastern Limited, 1971 and 1975);
- Project Proforma (PP) on Kurigram Flood Control and Irrigation Project (South Unit), Bangladesh Water Development Board, Dhaka, September 1987.
- Kurigram Flood Control and Irrigation Project, Office of the Superintending Engineer, Teesta Project Canal Circle-2, BWDB, Rangpur, September 1990 (Bengali version).

Information relevant to the Project was also collected through discussions with BWDB officials and interviews with local people. The most important source of quantified data was the agricultural module of the PIE sample survey of farm households (Module B). This provided data on all the plots of land cultivated by a random sample of 105 farm households in the impacted protected area, 15 farm households in the unprotected impacted area, and 60 farm households in the control area. From this data a comparison has been made between pre- and post-project conditions and between with- and without-project conditions

3.3 ASSESSMENT OF HYDROLOGICAL IMPACTS

3.3.1. Introduction

The Project impacts all stem from hydrological changes which result in differences in water conditions between the pre- and post-protection period. The adequacy of the Project infrastructure for its purposes has been assessed as far as possible in Chapter 2, however this did not quantify the impacts of the Project on hydrological conditions.

3.3.2 Impacts on Flood Type

Post-project hydrological characteristics in the Kurigram South Unit are representative Flood Type M (see Section 2.1.2). Hence the Project has not changed the overall flood characteristics of the area. As will be shown monsoon water conditions within the Project have been modified, but not to a great extent. However, flash floods from outside the Project have been reduced. The hydrographs in Figure 3.1 show external and internal water levels at the Bamni regulator site during monsoon season in 1990. The hydrographs prove the fact that the Project, and that regulator in particular, operated successfully throughout the season. In particular the hydrographs during August show flood peaks being reduced and more stable water levels inside the Project. The embankment suffers breaches, due to bank erosion, and frequent public cuts, due to drainage congestion, which limit the hydrological impact.

However, outside the Project there is no evidence of any great hydrological impact (although local people claim to be adversely affected this is difficult to prove as the areas involved are active floodplains). There is no backflow effect and the external water levels show no changing trend because the Project area adjoins the very large Brahmaputra river.

3.3.3 Background to Household Survey

The agricultural module of the PIE farm household survey collected data on flooding, drainage and irrigation status of the land cultivated by sampled households. As such, the survey does not provide information on hydrological changes on land which was uncultivated pre-project (for example, most of the lowest beels). Nevertheless it is 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).

The sample households were selected by two stage random sampling; the first stage sampling unit was the mouza, and the second one was the household in the selected mouzas. The farm household survey covers a sample of 73.93 ha of cultivated land in the impacted-protected area, 8.12 ha in the impacted-unprotected area, and 70.50 ha in the control area.

3.3.4 Impact on Flood Depth and Duration

The Project area includes a relatively high area between the two major rivers of Teesta and Dharla, hence not much impact can be seen on the distribution of cultivated area either by flood depth (Table 3.1) or by inundation duration (Table 3.2), since a high percentage of cultivated land belongs to the high land category both in the protected area (47 per cent) and in the control area (57 per cent). In addition, the pre-project condition referred to in the interviews was based on 1981, two years before the project completion, it may be that the Project had already affected normal monsoon water levels by that time. Figures 3.2 and 3.3 indicate that some caution should be used in interpreting the control area as representing without project conditions since it had more high land and less medium-low land even before the Project. However, these Figures do show that inundation depths and durations have changed in the Project whereas there has been no change in the control area. The impact can be summarised as:

Figure 3.1 Gauge Reading for Bamni Regulator (KS - 1990)

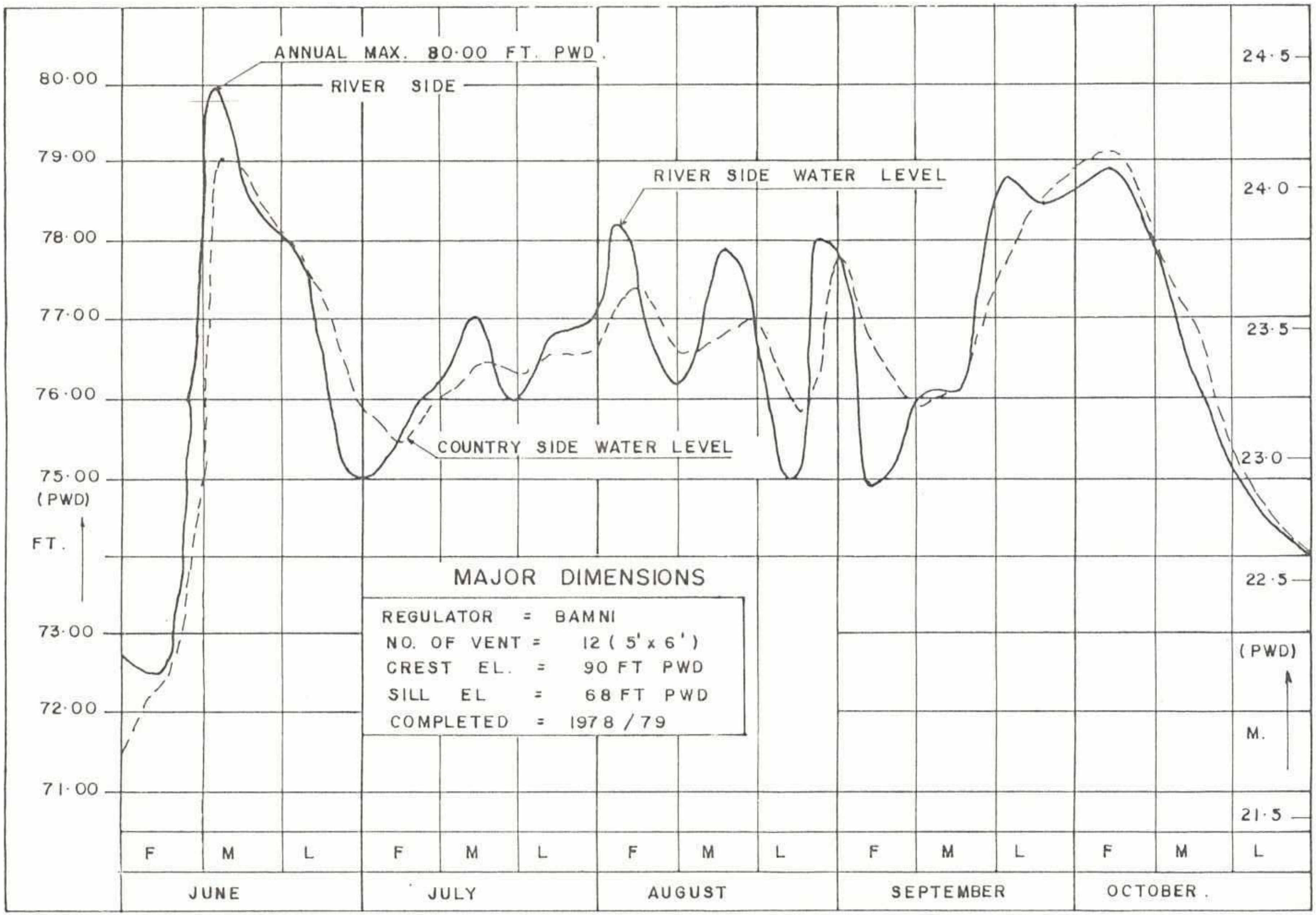

Table 3.1 Cultivated Land by Flood Depth (KS)

(Unit: ha)

Flood Depth	Impacted Area						Control Area		
	Protected Area			Unprotected Area					
	Before	Present	Increase	Before	Present	Increase	Before	Present	Increase
High (%)	32.51 (44.0)	34.81 (47.1)	2.30 (3.1)	1.00 (12.3)	0.75 (9.2)	-0.25 (-3.1)	39.45 (56.0)	39.97 (56.7)	0.52 (0.7)
Medium High (%)	5.79 (7.8)	11.89 (16.1)	6.10 (8.3)	0.89 (11.0)	1.20 (14.8)	0.31 (3.8)	11.23 (15.9)	12.36 (17.5)	1.13 (1.6)
Medium Low (%)	19.86 (26.8)	17.49 (23.6)	-2.37 (-3.2)	1.90 (23.4)	1.81 (22.3)	-0.09 (-1.1)	7.57 (10.7)	7.26 (10.3)	-0.31 (-0.4)
Low (%)	12.32 (16.7)	8.29 (11.2)	-4.03 (-5.5)	3.95 (48.6)	3.98 (49.0)	0.03 (0.4)	8.76 (12.4)	8.38 (11.9)	-0.38 (-0.5)
Very Low (%)	3.45 (4.7)	1.45 (2.0)	-2.00 (-2.7)	0.38 (4.7)	0.38 (4.7)	- (-)	3.49 (5.0)	2.53 (3.6)	-0.96 (-1.4)
Total (%)	73.93 (100.0)	73.93 (100.0)	- (-)	8.12 (100.0)	8.12 (100.0)	- (-)	70.50 (100.0)	70.50 (100.0)	- (-)

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

Source: PIE Farm Household Survey

Table 3.2 Cultivated Land by Duration of Inundation (KS)

(Unit: ha)

Inundation Duaration (months)	Impacted Area						Control Area		
	Protected Area			Unprotected Area					
	Before	Present	Increase	Before	Present	Increase	Before	Present	Increase
0 (%)	35.47 (48.0)	39.26 (53.1)	3.79 (5.1)	0.75 (9.2)	0.75 (9.2)	- (-)	48.00 (68.1)	48.52 (68.8)	0.52 (0.7)
0 - 1 (%)	5.97 (8.1)	8.18 (11.1)	2.21 (3.0)	0.71 (8.8)	0.71 (8.8)	- (-)	2.28 (3.2)	2.62 (3.7)	0.34 (0.5)
1 - 2 (%)	7.94 (10.7)	8.12 (11.0)	0.18 (0.3)	0.75 (9.2)	0.75 (9.2)	- (-)	2.80 (4.0)	1.86 (2.7)	-0.94 (-1.3)
2 - 3 (%)	8.18 (11.1)	6.14 (8.3)	-2.04 (-2.8)	1.01 (12.5)	1.30 (16.0)	0.29 (3.5)	4.90 (7.0)	4.22 (6.0)	-0.68 (-1.0)
3 - 4 (%)	7.60 (10.3)	4.68 (6.3)	-2.92 (-4.0)	2.56 (31.5)	2.27 (28.0)	-0.29 (-3.5)	2.11 (3.0)	2.11 (3.0)	- (-)
4 - 5 (%)	2.07 (2.8)	3.06 (4.1)	0.99 (1.3)	2.07 (25.5)	2.07 (25.5)	- (-)	3.83 (5.4)	4.67 (6.6)	0.84 (1.2)
5 - 6 (%)	2.61 (3.5)	1.37 (1.9)	-1.24 (-1.6)	0.02 (0.2)	0.02 (0.2)	- (-)	0.94 (1.3)	1.07 (1.5)	0.13 (0.2)
6 and over (%)	4.09 (5.5)	3.12 (4.2)	-0.97 (-1.3)	0.25 (3.1)	0.25 (3.1)	- (-)	5.64 (8.0)	5.43 (7.7)	-0.21 (-0.3)
Total (%)	73.93 (100.0)	73.93 (100.0)	- (-)	8.12 (100.0)	8.12 (100.0)	- (-)	70.50 (100.0)	70.50 (100.0)	- (-)

Source: PIE Farm Household Survey

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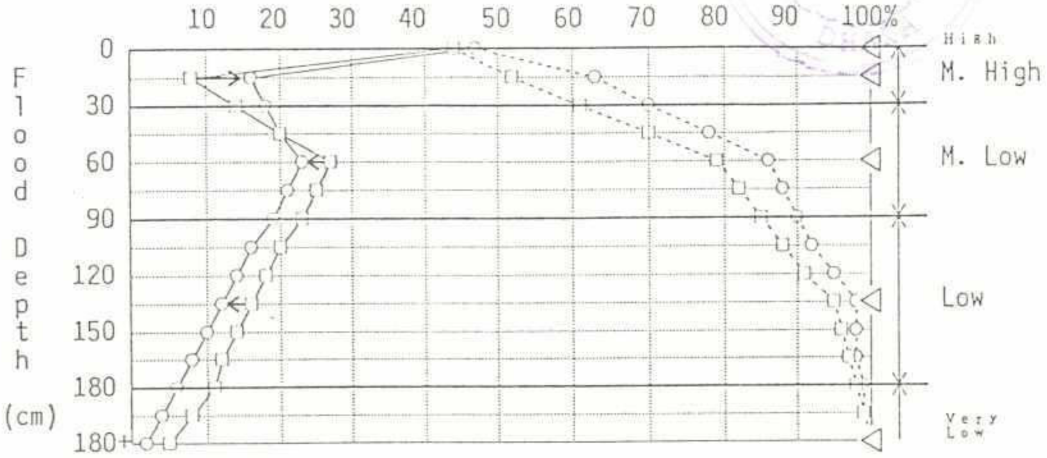
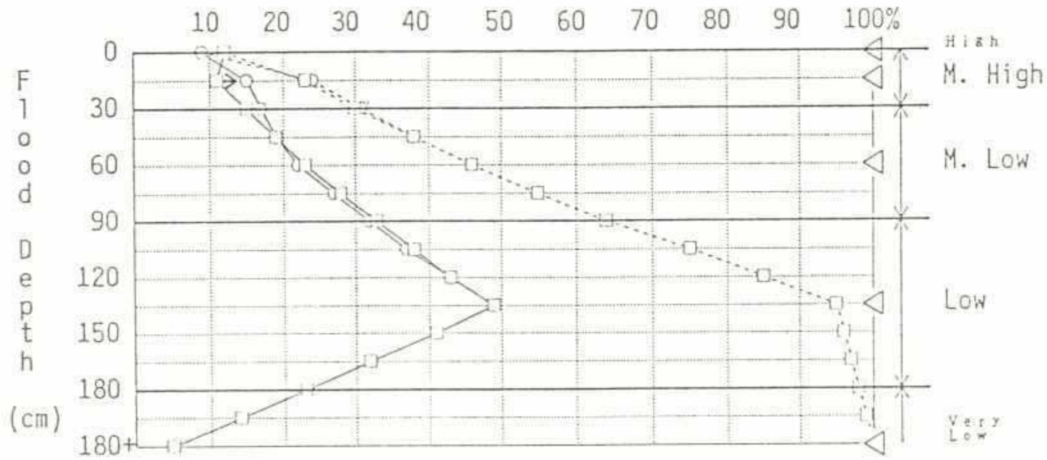
Figure 3.2 Cultivated Land by Flood Depth (KS)

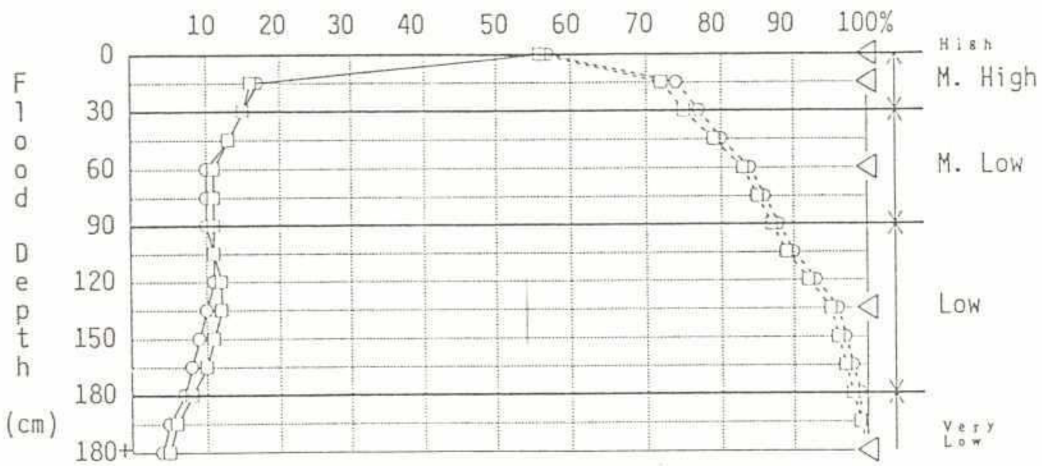
(1) Impacted Area - Protected



(2) Impacted Area - Unprotected



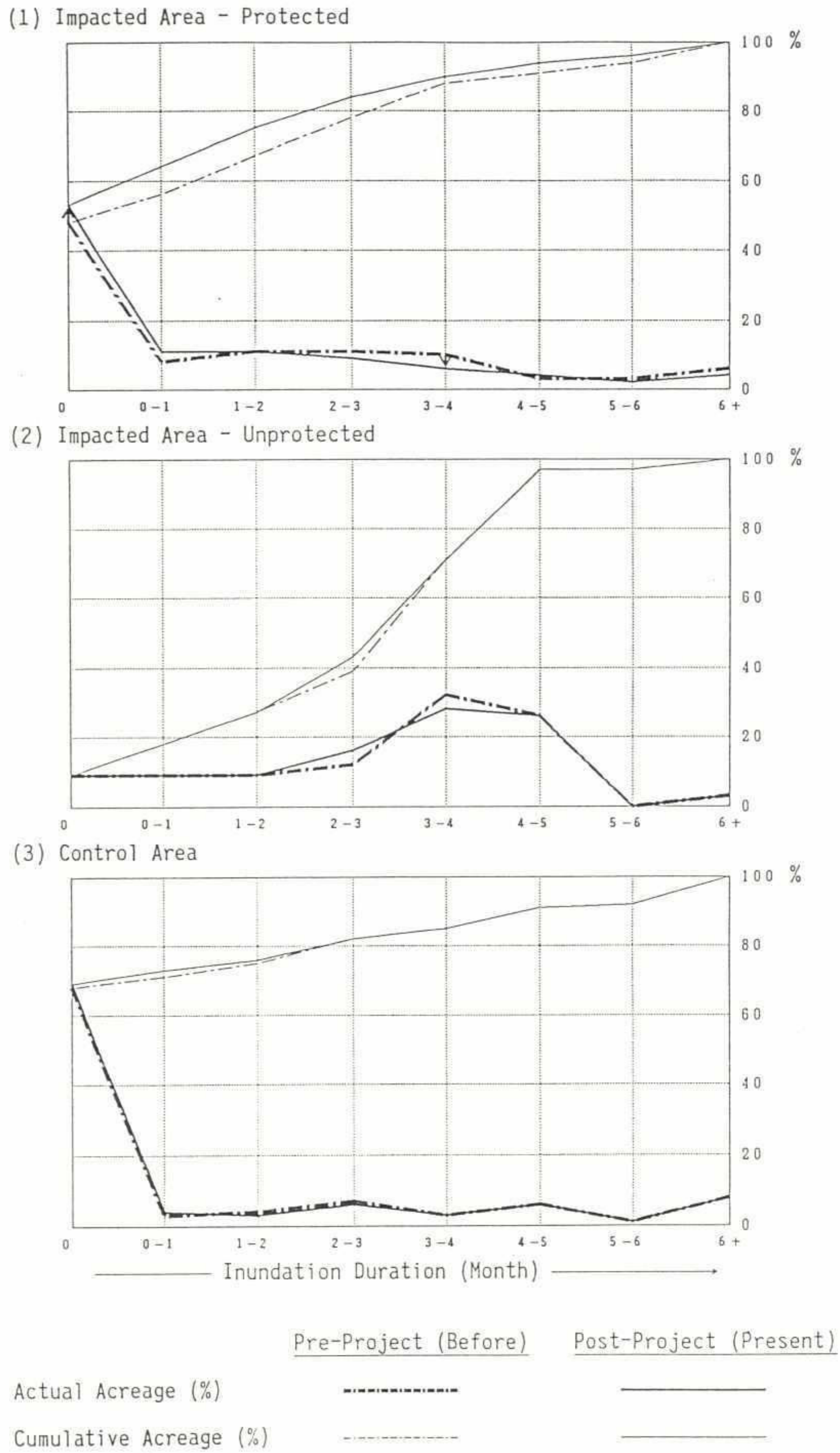
(3) Control Area



——— Actual Acreage (%) .... Cumulative Acreage (%)

□ Pre-Project, ○ Post-Project, ◁ Median of Range

Figure 3.3 Cultivated Land by Duration of Inundation (KS)



- the cultivated land subject to shallower depth of normal flooding (less than 30 cm) increased slightly from 38.30 ha (51.8 per cent) to 46.70 ha (63.2 per cent), with a corresponding decrease in the area under the deeper flood depth (more than 30 cm) from 35.63 ha (48.2 per cent) to 27.23 ha (36.8 per cent), as a positive impact in the impacted-protected area;

- in the control area there has been little change in normal flood characteristics, but there has been a marginal increase of 1.65 ha (2.3 per cent) under shallower depth of normal flooding (less than 30 cm), with a corresponding decrease in the area under deeper water (more than 30 cm). It is possible that the Kurigram North Project has had some effect on this area, but it is clearly not significant;

- the cultivated land subject to shorter inundation periods (less than two months) increased from 49.38 ha (66.8 per cent) to 55.56 ha (75.2 per cent) with a corresponding but small decrease in the area flooded for 3-4 months, there are no real changes in flood duration in the control area.

3.3.5 Changes in Irrigation

Although the Kurigram Flood Control and Irrigation Project (South Unit) was designed as a full FCD/I scheme, only the flood protection embankment and drainage facilities were constructed, the irrigation component has been left behind because of financial constraints. In this connection, BWDB had decided to update the previous feasibility studies. JICA commissioned a Feasibility Study in 1991, of which one of the major objectives is to formulate a comprehensive project plan incorporating the concept of conjunctive use of surface water and groundwater to expand irrigation, as well as providing flood control and drainage facilities to the project area.

Presently, local farmers are irrigating mainly their rabi season crops by using retained water in beels and khals as well as groundwater. Tables 3.3 to 3.5 and Figure 3.4 give the post-project irrigation condition in the impacted and the control areas. In interpreting Figure 3.4 it should be noted that the axes of the graphs are of equal length but the various land levels occur in different proportions and this is not reflected in the graphs.

The following impacts on irrigation can be summarised:

- in both the protected area and the control area irrigation is practised in every land level during the rabi season. In the former area 43 per cent of the cultivated land is irrigated, ranging between 20 and 50 per cent by land levels with higher percentages for medium-low and low land. In the control area 31 per cent is under irrigation (with a similar distribution by land levels as in the protected area). Hence there is still a considerable area without irrigation and with potential for expansion of irrigation;

- virtually all irrigated land is under winter cultivation: 84 per cent, 97 per cent and 92 per cent of irrigated land in the impacted-protected area, the impacted-unprotected area and the control area, respectively. Although several rabi crops are grown with irrigation, HYV Boro occupies over 85 per cent of the season's irrigated area. Cultivation of HYV Boro is dependent on irrigation;

Table 3.3 Irrigation Area by Flood Depth and Crop Season (KS)

(Unit: ha)

Crop		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
Aus, B, LV	Crp. A.	7.45	-	-	-	-	7.45	-	-	-	-	-	-	-	-	-	-	-	-
	Irr. A.	0.42	-	-	-	-	0.42	-	-	-	-	-	-	-	-	-	-	-	-
	(%)	(5.6)	-	-	-	-	(5.6)	-	-	-	-	-	-	-	-	-	-	-	-
Aus, T, HYV	Crp. A.	1.35	1.87	0.60	0.36	-	4.18	-	-	-	0.08	-	0.08	9.64	2.11	-	-	-	11.75
	Irr. A.	1.30	1.01	0.10	0.14	-	2.55	-	-	-	0.08	-	0.08	0.64	0.81	-	-	-	1.45
	(%)	(96.3)	(54.0)	(16.7)	(38.9)	-	(61.0)	-	-	-	(100)	-	(100)	(6.6)	(38.4)	-	-	-	(12.3)
Betel Leaves	Crp. A.	0.04	-	-	-	-	0.04	-	-	-	-	-	-	-	-	-	-	-	-
	Irr. A.	0.04	-	-	-	-	0.04	-	-	-	-	-	-	-	-	-	-	-	-
	(%)	(100)	-	-	-	-	(100)	-	-	-	-	-	-	-	-	-	-	-	-
Jute	Crp. A.	-	-	-	-	-	-	-	-	-	-	-	-	9.64	-	-	-	-	9.64
	Irr. A.	-	-	-	-	-	-	-	-	-	-	-	-	0.26	-	-	-	-	0.26
	(%)	-	-	-	-	-	-	-	-	-	-	-	-	(2.7)	-	-	-	-	(2.7)
Others	Crp. A.	0.16	-	-	-	-	0.16	-	-	-	-	-	-	-	-	-	-	-	-
	Irr. A.	0.16	-	-	-	-	0.16	-	-	-	-	-	-	-	-	-	-	-	-
	(%)	(100)	-	-	-	-	(100)	-	-	-	-	-	-	-	-	-	-	-	-
Aus, Total	Crp. A.	9.00	1.87	0.60	0.36	-	11.83	-	-	-	0.08	-	0.08	19.28	2.11	-	-	-	21.39
	Irr. A.	1.92	1.01	0.10	0.14	-	3.17	-	-	-	0.08	-	0.08	0.90	0.81	-	-	-	1.71
	(%)	(21.3)	(54.0)	(16.7)	(38.9)	-	(26.8)	-	-	-	(100)	-	(100)	(4.7)	(38.4)	-	-	-	(8.0)
Aman, T, LV	Crp. A.	21.95	8.55	14.45	-	-	44.95	-	-	-	-	-	-	31.75	-	-	-	-	31.75
	Irr. A.	2.04	0.40	0.13	-	-	2.57	-	-	-	-	-	-	0.13	-	-	-	-	0.13
	(%)	(9.3)	(4.7)	(0.9)	-	-	(5.7)	-	-	-	-	-	-	(0.4)	-	-	-	-	(0.4)
Aman, T, HYV	Crp. A.	4.18	-	-	-	-	4.18	-	-	-	-	-	-	-	-	-	-	-	-
	Irr. A.	0.40	-	-	-	-	0.40	-	-	-	-	-	-	-	-	-	-	-	-
	(%)	(9.6)	-	-	-	-	(9.6)	-	-	-	-	-	-	-	-	-	-	-	-
Aman, Total	Crp. A.	26.13	8.55	14.45	-	-	49.13	-	-	-	-	-	-	31.75	-	-	-	-	31.75
	Irr. A.	2.44	0.40	0.13	-	-	2.97	-	-	-	-	-	-	0.13	-	-	-	-	0.13
	(%)	(9.3)	(4.7)	(0.9)	-	-	(6.0)	-	-	-	-	-	-	(0.4)	-	-	-	-	(0.4)
Boro, LV	Crp. A.	-	-	0.14	-	-	0.14	-	-	-	-	-	-	-	-	-	0.99	-	0.99
	Irr. A.	-	-	0.14	-	-	0.14	-	-	-	-	-	-	-	-	-	0.79	-	0.79
	(%)	-	-	(100)	-	-	(100)	-	-	-	-	-	-	-	-	-	(79.8)	-	(79.8)
Boro, HYV	Crp. A.	12.48	2.85	7.76	3.74	0.29	27.12	-	-	0.94	0.72	0.38	2.04	9.05	2.57	4.11	3.88	0.81	20.42
	Irr. A.	12.23	2.84	7.75	3.74	0.29	26.85	-	-	0.94	0.72	0.38	2.04	9.05	2.56	4.11	3.62	0.81	20.15
	(%)	(98.0)	(99.6)	(99.9)	(100)	(100)	(99.0)	-	-	(100)	(100)	(100)	(100)	(100)	(99.6)	(100)	(93.3)	(100)	(98.7)
Wheat	Crp. A.	1.94	-	0.30	1.02	-	3.26	-	-	-	0.16	-	0.16	4.14	-	-	-	-	4.14
	Irr. A.	0.98	-	0.20	0.32	-	1.50	-	-	-	0.10	-	0.10	0.53	-	-	-	-	0.53
	(%)	(50.5)	-	(66.7)	(31.4)	-	(46.0)	-	-	-	(62.5)	-	(62.5)	(12.8)	-	-	-	-	(12.8)
Potato	Crp. A.	3.86	-	-	-	-	3.86	-	-	-	-	-	-	0.97	-	-	-	-	0.97
	Irr. A.	1.59	-	-	-	-	1.59	-	-	-	-	-	-	0.12	-	-	-	-	0.12
	(%)	(41.2)	-	-	-	-	(41.2)	-	-	-	-	-	-	(12.4)	-	-	-	-	(12.4)
Tobacco	Crp. A.	0.07	0.46	-	-	-	0.53	-	-	-	-	-	-	-	-	-	-	-	-
	Irr. A.	0.07	0.46	-	-	-	0.53	-	-	-	-	-	-	-	-	-	-	-	-
	(%)	(100)	(100)	-	-	-	(100)	-	-	-	-	-	-	-	-	-	-	-	-
Pepper	Crp. A.	0.50	-	-	-	-	0.50	-	-	0.16	-	-	0.16	-	-	-	-	-	-
	Irr. A.	0.32	-	-	-	-	0.32	-	-	0.16	-	-	0.16	-	-	-	-	-	-
	(%)	(64.0)	-	-	-	-	(64.0)	-	-	(100)	-	-	(100)	-	-	-	-	-	-
Onion/Garlic	Crp. A.	0.02	-	-	-	-	0.02	-	-	-	-	-	-	-	-	-	-	-	-
	Irr. A.	0.02	-	-	-	-	0.02	-	-	-	-	-	-	-	-	-	-	-	-
	(%)	(100)	-	-	-	-	(100)	-	-	-	-	-	-	-	-	-	-	-	-
Winter Vegetables	Crp. A.	0.75	-	-	-	-	0.75	-	-	-	-	-	-	0.28	-	-	-	-	0.28
	Irr. A.	0.41	-	-	-	-	0.41	-	-	-	-	-	-	0.13	-	-	-	-	0.13
	(%)	(54.7)	-	-	-	-	(54.7)	-	-	-	-	-	-	(46.4)	-	-	-	-	(46.4)
Betel Leaves	Crp. A.	0.04	-	-	-	-	0.04	-	-	-	-	-	-	-	-	-	-	-	-
	Irr. A.	0.04	-	-	-	-	0.04	-	-	-	-	-	-	-	-	-	-	-	-
	(%)	(100)	-	-	-	-	(100)	-	-	-	-	-	-	-	-	-	-	-	-
Others	Crp. A.	0.03	-	-	-	-	0.03	-	-	-	-	-	-	-	-	-	-	-	-
	Irr. A.	0.03	-	-	-	-	0.03	-	-	-	-	-	-	-	-	-	-	-	-
	(%)	(100)	-	-	-	-	(100)	-	-	-	-	-	-	-	-	-	-	-	-
Rabi/Boro, Total	Crp. A.	19.69	3.31	8.20	4.76	0.29	36.25	-	-	1.10	0.88	0.38	2.36	14.44	2.57	4.11	4.87	0.81	25.80
	Irr. A.	15.69	3.30	8.09	4.06	0.29	31.43	-	-	1.10	0.82	0.38	2.30	9.83	2.56	4.11	4.41	0.81	21.72
	(%)	(79.7)	(99.7)	(98.7)	(85.3)	(100)	(86.7)	-	-	(100)	(93.2)	(100)	(97.5)	(68.1)	(99.6)	(100)	(90.6)	(100)	(81.0)
Grand Total	Crp. A.	54.82	13.73	23.25	5.12	0.29	97.21	-	-	1.10	0.96	0.38	2.44	65.47	4.68	4.11	4.87	0.81	79.94
	Irr. A.	20.05	4.71	8.32	4.20	0.29	37.57	-	-	1.10	0.90	0.38	2.38	10.86	3.37	4.11	4.41	0.81	23.56
	(%)	(36.6)	(34.3)	(35.8)	(82.0)	(100)	(38.6)	-	-	(100)	(93.8)	(100)	(97.5)	(16.6)	(72.0)	(100)	(90.6)	(100)	(29.5)

Flood Depth: H. = High (never flooded), M.H. = Medium High (0 - 30 cm), M.L. = Medium Low (30 - 90 cm), L. = Low (90 - 180 cm), V.L. = Very Low (over 180 cm)

Note: Crp. A. = Cropped Area, Irr. A. = Irrigated Area

Source: PIE Farm Household Survey

Table 3.4 Irrigation Area by Flood Depth and Means (KS)

(Unit: ha)

Crop	Flood Depth	Impacted Area												Control Area					
		Protected Area						Unprotected Area											
		DTW	STW	LLP	Ind.	MOSTI	Total	DTW	STW	LLP	Ind.	MOSTI	Total	DTW	STW	LLP	Ind.	MOSTI	Total
Aus	High	0.42	1.18	-	-	0.32	1.92	-	-	-	-	-	-	0.64	0.13	-	0.13	-	0.90
	M.H.	-	1.01	-	-	-	1.01	-	-	-	-	-	-	0.81	-	-	-	-	0.81
	M.L.	-	0.10	-	-	-	0.10	-	-	-	-	-	-	-	-	-	-	-	-
	Low	-	0.14	-	-	-	0.14	0.08	-	-	-	-	0.08	-	-	-	-	-	-
	V.L.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Total	0.42	2.43	-	-	0.32	3.17	0.08	-	-	-	-	0.08	1.45	0.13	-	0.13	-	1.71
Aman	High	0.40	1.62	0.42	-	-	2.44	-	-	-	-	-	-	-	-	-	0.13	-	0.13
	M.H.	-	0.40	-	-	-	0.40	-	-	-	-	-	-	-	-	-	-	-	-
	M.L.	-	0.13	-	-	-	0.13	-	-	-	-	-	-	-	-	-	-	-	-
	Low	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	V.L.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Total	0.40	2.15	0.42	-	-	2.97	-	-	-	-	-	-	-	-	-	0.13	-	0.13
Rabi/Boro	High	1.80	11.55	0.56	1.29	0.49	15.69	-	-	-	-	-	-	2.74	5.26	0.51	1.13	0.19	9.83
	M.H.	0.18	2.66	-	0.06	0.40	3.30	-	-	-	-	-	-	0.80	1.03	0.13	0.60	-	2.56
	M.L.	1.26	4.37	2.04	0.42	-	8.09	-	0.94	-	0.16	-	1.10	0.13	3.41	0.57	-	-	4.11
	Low	-	2.94	0.66	0.46	-	4.06	0.10	0.60	-	0.12	-	0.82	-	4.02	-	0.39	-	4.41
	V.L.	-	0.22	-	0.07	-	0.29	-	0.38	-	-	-	0.38	-	0.81	-	-	-	0.81
	Total	3.24	21.74	3.26	2.30	0.89	31.43	0.10	1.92	-	0.28	-	2.30	3.67	14.53	1.21	2.12	0.19	21.72
Total	High	2.62	14.35	0.98	1.29	0.81	20.05	-	-	-	-	-	-	3.38	5.39	0.51	1.39	0.19	10.86
	M.H.	0.18	4.07	-	0.06	0.40	4.71	-	-	-	-	-	-	1.61	1.03	0.13	0.60	-	3.37
	M.L.	1.26	4.60	2.04	0.42	-	8.32	-	0.94	-	0.16	-	1.10	0.13	3.41	0.57	-	-	4.11
	Low	-	3.08	0.66	0.46	-	4.20	0.18	0.60	-	0.12	-	0.90	-	4.02	-	0.39	-	4.41
	V.L.	-	0.22	-	0.07	-	0.29	-	0.38	-	-	-	0.38	-	0.81	-	-	-	0.81
	Total	4.06	26.32	3.68	2.30	1.21	37.57	0.18	1.92	-	0.28	-	2.38	5.12	14.66	1.21	2.38	0.19	23.56

Irrigation Means: DTW = Deep Tube Well, STW = Shallow Tube Well, LLP = Low Lift Pump, Ind. = Indigenous Ones, MOSTI = Mannually Operated Shallow Tube Well

Flood Depth: High = Never flooded, M.H. = 0 - 30 cm, M.L. = 30 - 90 cm, L. = 90 - 180 cm, V.L. = over 180 cm

Source: PIE Farm Household Survey

Table 3.5 Irrigated Area by Means and Crop Season (KS)

(Unit: ha)

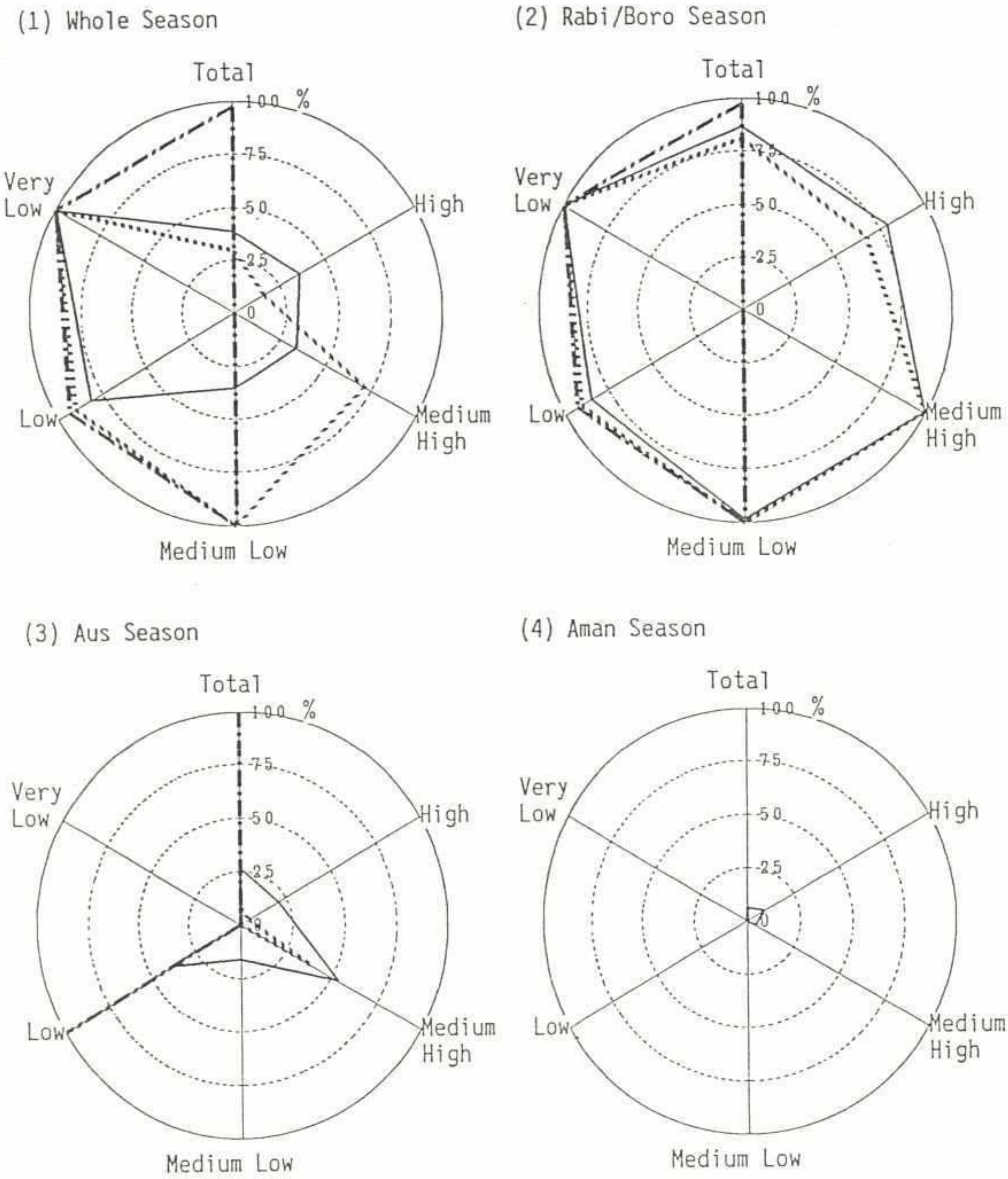
Crop		Impacted Area												Control Area					
		Protected Area						Unprotected Area											
		DTW	STW	LLP	Ind.	MOSTI	Total	DTW	STW	LLP	Ind.	MOSTI	Total	DTW	STW	LLP	Ind.	MOSTI	Total
Aus, B	Irr. A.	-	0.14	-	-	0.28	0.42	-	-	-	-	-	-	-	-	-	-	-	-
	(%)	(-)	(33.3)	(-)	(-)	(66.7)	(100)	-	-	-	-	-	-	-	-	-	-	-	-
Aus, T, HYV	Irr. A.	0.26	2.29	-	-	-	2.55	0.08	-	-	-	-	0.08	1.45	-	-	-	-	1.45
	(%)	(10.2)	(89.8)	(-)	(-)	(-)	(100)	(100)	(-)	(-)	(-)	(-)	(100)	(100)	(-)	(-)	(-)	(-)	(100)
Betel Leaves	Irr. A.	-	-	-	-	0.04	0.04	-	-	-	-	-	-	-	-	-	-	-	-
	(%)	(-)	(-)	(-)	(-)	(100)	(100)	-	-	-	-	-	-	-	-	-	-	-	-
Jute	Irr. A.	-	-	-	-	-	-	-	-	-	-	-	-	-	0.13	-	0.13	-	0.26
	(%)	-	-	-	-	-	-	-	-	-	-	-	-	(-)	(50.0)	(-)	(50.0)	(-)	(100)
Others	Irr. A.	0.16	-	-	-	-	0.16	-	-	-	-	-	-	-	-	-	-	-	-
	(%)	(100)	(-)	(-)	(-)	(-)	(100)	-	-	-	-	-	-	-	-	-	-	-	-
Aus, Total	Irr. A.	0.42	2.43	-	-	0.32	3.17	0.08	-	-	-	-	0.08	1.45	0.13	-	0.13	-	1.71
	(%)	(13.2)	(75.7)	(-)	(-)	10.10	(100)	(100)	(-)	(-)	(-)	(-)	(100)	(84.8)	(7.6)	(-)	(7.6)	(-)	(100)
Aman, T, LV	Irr. A.	-	2.15	0.42	-	-	2.57	-	-	-	-	-	-	-	-	-	0.13	-	0.13
	(%)	(-)	(83.7)	(16.3)	(-)	(-)	(100)	-	-	-	-	-	-	(-)	(-)	(-)	(100)	(-)	(100)
Aman, T, HYV	Irr. A.	0.40	-	-	-	-	0.40	-	-	-	-	-	-	-	-	-	-	-	-
	(%)	(100)	(-)	(-)	(-)	(-)	(100)	-	-	-	-	-	-	-	-	-	-	-	-
Aman, Total	Irr. A.	0.40	2.15	0.42	-	-	2.97	-	-	-	-	-	-	-	-	-	0.13	-	0.13
	(%)	(13.5)	(72.4)	(14.1)	(-)	(-)	(100)	-	-	-	-	-	-	(-)	(-)	(-)	(100)	(-)	(100)
Boro, LV	Irr. A.	-	0.14	-	-	-	0.14	-	-	-	-	-	-	-	0.40	-	0.39	-	0.79
	(%)	(-)	(100)	(-)	(-)	(-)	(100)	-	-	-	-	-	-	(-)	(50.6)	(-)	(49.4)	(-)	(100)
Boro, HYV	Irr. A.	3.04	20.28	3.10	0.43	-	26.85	-	1.92	-	0.12	-	2.04	3.67	14.00	1.21	1.27	-	20.15
	(%)	(11.3)	(75.5)	(11.5)	(1.6)	(-)	(100)	(-)	(94.1)	(-)	(5.9)	(-)	(100)	(18.2)	(69.5)	(6.0)	(6.3)	(-)	(100)
Wheat	Irr. A.	-	0.53	-	0.92	0.05	1.50	0.10	-	-	-	-	0.10	-	0.13	-	0.27	0.13	0.53
	(%)	(-)	(35.3)	(-)	(61.3)	(3.3)	(100)	(100)	(-)	(-)	(-)	(-)	(100)	(-)	(24.5)	(-)	(50.9)	(24.5)	(100)
Potato	Irr. A.	0.20	0.67	-	0.45	0.27	1.59	-	-	-	-	-	-	-	-	-	0.06	0.06	0.12
	(%)	(12.6)	(42.1)	(-)	(28.3)	(17.0)	(100)	-	-	-	-	-	-	(-)	(-)	(-)	(50.0)	(50.0)	(100)
Tobacco	Irr. A.	-	-	-	0.13	0.40	0.53	-	-	-	-	-	-	-	-	-	-	-	-
	(%)	(-)	(-)	(-)	(24.5)	(75.5)	(100)	-	-	-	-	-	-	-	-	-	-	-	-
Pepper	Irr. A.	-	0.12	-	0.15	0.05	0.32	-	-	-	0.16	-	0.16	-	-	-	-	-	-
	(%)	(-)	(37.5)	(-)	(46.9)	(15.6)	(100)	(-)	(-)	(-)	(100)	(-)	(100)	-	-	-	-	-	-
Onion/Garlic	Irr. A.	-	-	-	-	0.02	0.02	-	-	-	-	-	-	-	-	-	-	-	-
	(%)	(-)	(-)	(-)	(-)	(100)	(100)	-	-	-	-	-	-	-	-	-	-	-	-
Winter Vegetables	Irr. A.	-	-	0.16	0.19	0.06	0.41	-	-	-	-	-	-	-	-	-	0.13	-	0.13
	(%)	(-)	(-)	(39.0)	(46.3)	(14.6)	(100)	-	-	-	-	-	-	(-)	(-)	(-)	(100)	(-)	(100)
Betel Leaves	Irr. A.	-	-	-	-	0.04	0.04	-	-	-	-	-	-	-	-	-	-	-	-
	(%)	(-)	(-)	(-)	(-)	(100)	(100)	-	-	-	-	-	-	-	-	-	-	-	-
Others	Irr. A.	-	-	-	0.03	-	0.03	-	-	-	-	-	-	-	-	-	-	-	-
	(%)	(-)	(-)	(-)	(100)	(-)	(100)	-	-	-	-	-	-	-	-	-	-	-	-
Rabi/Boro, Total	Irr. A.	3.24	21.74	3.26	2.30	0.89	31.43	0.10	1.92	-	0.28	-	2.30	3.67	14.53	1.21	2.12	0.19	21.72
	(%)	(10.3)	(69.2)	(10.4)	(7.3)	(2.8)	(100)	(4.3)	(83.5)	(-)	(12.2)	(-)	(100)	(16.9)	(66.9)	(5.6)	(9.8)	(0.9)	(100)
Grand Total	Irr. A.	4.06	26.32	3.68	2.30	1.21	37.57	0.18	1.92	-	0.28	-	2.38	5.12	14.66	1.21	2.38	0.19	23.56
	(%)	(10.8)	(70.1)	(9.8)	(6.1)	(3.2)	(100)	(7.6)	(80.7)	(-)	(11.8)	(-)	(100)	(21.7)	(62.2)	(5.1)	(10.1)	(0.8)	(100)

Irrigation Mean: DTW = Deep Tube Well, STW = Shallow Tube Well, LLP = Low Lift Pump, Ind. = Indigenous Ones, BWDB = BWDB Canal

Flood Depth: High = Never flooded, M.H. = 0 - 30 cm, M.L. = 30 - 90 cm, L. = 90 - 180 cm, V.L. = over 180 cm

Source: PIE Farm Household Survey

Figure 3.4 Cropped Area under Irrigation by Flood Depth and Season (KS)



	Total Cropped Area (ha)				Legend
	Whole Sea.	Rabi/Boro	Aus	Aman	
Protected	97.21	36.25	11.83	49.13	————
Unprotected	2.44	2.36	0.08	-	-·-·-·-·-
Control	79.94	26.80	21.39	31.75	············

- irrigation is by small scale methods. In the impacted-protected area 70 per cent of the irrigated area across all seasons is covered by STWs, followed by DTWs (11 per cent) and LLPs (10 per cent). STWs dominate irrigation (81 per cent) in the impacted-unprotected area. In the control area STWs cover 62 per cent of the irrigated area followed by DTWs (22 per cent). On high and medium-high land STWs irrigate 74 per cent of land (and DTWs 11 per cent), whereas in the control area, 45 per cent is covered by STWs and 35 per cent by DTWs.

Hence irrigation has become widespread since the Project, but the same trend has been apparent in the control area. It is not clear if there is any link between the slightly higher percentage of land irrigated in the Project area and the FCD project. While it might be argued that the Project provides a more secure environment for investment in tubewells, the problems of breaches and cuts suggest that this is not the case.

3.3.6 Hydrological Comparability of Control Area

In order to evaluate the appropriateness of the selected control area as a guide to the without-project condition, correlation coefficients between the impacted and the control areas under pre-project condition have been calculated for flood depth and duration (using the category means). The results are summarised below:

Flood Depth (n=5)	:	R=0.810
Inundation Duration (n=8)	:	R=0.966

Although the number of categories in the sample are rather small, these correlation coefficients give a satisfactory justification for selection of the control area in the farm household survey.

3.4 CONCLUSIONS ON HYDROLOGICAL IMPACT

The impact of Kurigram South in reducing normal flood depth and duration has been modest. However, in pre-project times floods were often of relatively short duration, particularly along the Teesta and Dharla and the interview surveys may not have been able to pick up a change in the incidence or severity of these short flood peaks which the hydrograph suggests has occurred. The surveys confirm that a large part of the Project was high land (flood free) before the Project and is unlikely to have benefited. In aggregate the data give no indication of worsened drainage conditions, but it is clear from the RRA and O&M surveys that parts of the area suffer from persistent drainage congestion.

The strategy of trying to protect the low-lying areas from flooding, especially where they are active meander floodplain lands, appears to be very expensive, and not very effective. It may be necessary to change the approach to FCD infrastructure in the area, maintaining protection for land at medium elevations, where TL Aman and HYV T Aman can be grown, and removing or abandoning the protection attempted for the low-lying areas which at present often suffer from acute drainage congestion or are open to flooding from breaches.

The proposals to develop a surface irrigation system do not appear justifiable, given the rapid recent expansion of irrigation using groundwater, and should be appraised in comparison with the alternative costs of further promoting STWs, MOSTI and DTWs. Given the poor O&M record in FCD/I projects and the lack of cost recovery in major irrigation projects in Bangladesh, it is very unlikely that a major irrigation system would be able to recover even O&M costs, whereas the private irrigation systems cover both O&M and capital costs.

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4 OPERATION AND MAINTENANCE

4.1 PRE-PROJECT SITUATION

Prior to Kurigram South Project, during the 1950s and 1960s, some short lengths of embankment had been built under local public works schemes, and bank protection measures had been taken along the Dharla near Kurigram Town. However, these measures appeared not to have been successful and there is no information on their O&M (Techno Consult, 1971). Prior to 1970 there appears to have been little local water management in the area. EPWAPDA had attempted to improve drainage around Deola Beel, but this was reported not to have been too successful and had reduced the availability of water for supplementary irrigation by indigenous means (Techno Consult, 1971).

4.2 INSTITUTIONAL FRAMEWORK

There is no special institutional framework for O&M of Kurigram South. In fact the Project is not under an O&M Division since it is not regarded as complete. Consequently the main concerns of the BWDB staff are for new works - additional regulators and bank protection works. The normal hierarchy of BWDB staff are in place in the Project, and staffing is discussed in Section 4.6.

One important aspect of the institutional arrangements is the problem of overlapping responsibilities. There are a number of small schemes under BWDB located within the Kurigram South Project (mainly for water retention). Since these schemes are completed they are the responsibility of Dinajpur O&M Division - whose offices are located far from the Project area. This is an obvious anomaly so far as water management is concerned. It would be more appropriate to place all BWDB water management in Kurigram South under one Division. This done there would still remain the complexity that there are a number of LGEB schemes for water management inside or adjacent to the Project, coordination is also needed between these and BWDB and vice versa. At present the drainage between BWDB and LGEB projects is interlinked, and it may be that additional regulators built by BWDB will pass on the problem of drainage congestion to LGEB scheme areas outside the Project.

4.3 PROJECT OPERATION

4.3.1 Operating Problems and Project Infrastructure

The original operating plan cannot be assessed, since drainage works appear to be incomplete. Hence the actual operation of the Project is assessed here based on the infrastructure constructed.

Drainage congestion has been observed in the lower parts of the area, resulting in numerous and frequent public cuts. Completion of the drainage component of the Project according to the original design might be necessary to counteract these negative effects. However, the old plan should not be blindly followed, but instead reassessed and modified following re-modelling.

a) Impact of flooding on drainage

In some cases drainage problems are likely to be the result of upstream openings in the embankment which result in flood water flowing into the Project. In September 1991 the railway line, which is supposed to form the flood protection barrier on the Project's north-west side, was overtopped just north of the Teesta bridge. Since BWDB is well aware that the adjacent Sati Nadi project which would provide flood protection to the railway has been eroded and open since 1987-88, prioritisation of at least an assessment of the protection afforded by the railway might have been expected.

b) Ratnai River

The embankment has at one point been left open where the Ratnai river enters the Project, resulting in flooding by the Ratnai River near the north-east boundary of the Project. However, a regulator was built at the outfall of this live river and in 1988 a 150m (500 ft) breach developed surrounding the Ratnai regulator, which has collapsed as a result of the breach and lies abandoned. The breach started with a public cut made to drain out flood water from the Ratnai river, but quickly expanded to take the flow of the river, and might well have breached without a cut. Operating problems here are ultimately due to poor planning and implementation since a live river draining areas outside the Project still enters the Project. However, according to local people, the problem in severe floods (1984, 1987, and 1988) is worsened by breaches in the embankment north of here which result in flood water flowing down to the regulator. The floods on the Ratnai have been sufficient to completely erode the approaches to the large bridge over it on the Phulbari road. The problem might be rectified by creating a diversion channel and extending the embankment up to the railway line, as in the original design, or by retreating from this part of the Project to the Ratnai right bank.

c) Regulators

Effective operation of the regulators is handicapped by the silting up of the natural drainage channels, and by open sections of embankment. However, the impression is that the regulators are relatively well operated (see also evidence in Chapter 3): khalashis were present at all the completed regulators and where there are no breaches and openings they function to keep out floods. The problem is in the lack of capacity to drain out excess quantities of water inside the Project when river levels fall, they are not operated to retain water.

d) Public cuts

The response to persistent drainage problems in several parts of the Project has been to cut the embankment. The main public cuts for drainage observed in 1991 (see Figure 1.2 for locations) are:

i. In Hokodanga there is a public cut of about 30m (100 ft) made by people from outside the embankment dating to immediately after its construction. The reason for cutting the embankment according to the local people is that the people living on the riverside of the project embankment are encircled by a ring bund made by Rangpur Dinajpur Rural Services (RDRS) and water within this area tends to drain into the Project area. So to release the drainage congestion the people in the ring bund area never allow any repair works to this cut by BWDB.

ii. In Haripur there is a public cut of about 46m (150 ft), this was made by the local people in 1990. The local people stated that the Harichari regulator (12-vent) was not fully operable at the time (4-vents operating out of 12-vents, although it appeared to be fully functioning in September 1991) which caused the water level to rise frequently in the country side inundating and damaging standing crops. This seems to be a persistent problem, in 1988 there had been a public cut some 150m upstream of this regulator to speed up drainage, that cut had been repaired during the next winter by BWDB. This regulator drains a substantial low lying area.

iii. In Chaslar Beel there is a public cut of about 46m (150 ft) which is close to a 1-vent pipe sluice ("Chaslar regulator"). This cut was made by the local people to drain out flood water in the 1988 flood. About 10-11 small beels within and outside the Putimari Kajal Danga area drain out through this cut.

iv. At the Ratnai regulator in addition to the breach there is a cut of about 38m (125 ft) which drains an ox-bow of the Ratnai river.

v. The recently constructed regulators under FDR funding are to take the place of public cuts, thus the "additional Bamni regulator" at Gaberjawan replaces a public cut which had been open since 1987, but the regulator had not been finished during the 1991 flood season - for which it had been closed with fallboards (see Table 2.4).

4.3.2 Operation of Non-project Infrastructure

It is unclear who implemented the pipe sluices in the embankment (Table 2.4), but these do not always serve the objective one might expect. Thus the Dalan pipe-sluice appears to be permanently open and drains an area outside the embankment into the Project since there would otherwise be drainage congestion in the area between the embankment and a village road outside the embankment.

Facilities under Kurigram South system are not the only BWDB water management facilities within the Project area. A khal from the Dhaolia Beel area (north of Rajahat Upazila centre) was excavated during the canal digging programme of the late 1970s, it links to an old river/drainage channel from Sarala Beel near Rajahat and flows out of the Project through the 16 vent regulator (Malbhanga) at Sitaighar. This sub-system has a series of water control structures intended for retention of water for irrigation in the post monsoon period. There are four sluices dating from 1961: apparently abandoned two vent sluices at Chhat Modha and Tograhat, an operated one at Ramarghat (not visited) and a functioning four vent sluice at Kismat Malbhanga close to the 16 vent regulator. The latter has been successfully operated with fallboards since completion, and the fallboards have been replaced twice. The khal is closed off in Ashin-Kartik to retain water which is lifted by LLP onto the fields. In addition a pipe-sluice with fallboard provision was built by RDRS in 1986/87 near the Kismat Malbhanga sluice, but has not been operated.

On the same sub-system close to Tograhat a weir was built in 1980/81, this is already in poor condition (wear of concrete aprons and loss of earth from the bunds. It is reported that the contractor provided poor quality fallboards and after the first season's operation they were taken by a UP member and used as firewood. The weir is now only used as a fish-trap.

As noted in Section 4.2 all of these "small" structures are under Dinajpur O&M Division and are not managed as part of the Kurigram South system.

4.3.3 Institutional and Social Assessment

Khalashis were found at all the main regulators of Kurigram South Project (excluding new regulators built under the FDR programme). Although they had not received detailed instructions or practical training in operating needs, the khalashis appeared to be operating the regulators sensibly. Most regulators had some gates open and others closed when the inside and outside water levels were equal during the visit in early September 1991, but were closed during a flood peak shortly afterwards. It was reported that fully opening or closing such large regulators can take three days, but this seems an excessive estimate. In general, middle gates are opened first to avoid damaging the regulators and their aprons. The khalashis are full time employees with the exception of the main Bamni regulator who's khalashi is paid on a daily basis. A part-time arrangement seems sensible for regulators in general as there are times of the year when little work is needed.

In no case was a committee found, operating decisions are made at the khalashis' discretion and at the request of farmers. Conflicts of interest between farmers were reported - in particular it was reported that the regulators helped drain more distant areas but did not relieve waterlogging near the regulators. Public cuts have been a frequent response to drainage problems when interior water levels are higher than river stages, however public cuts have **not** been repaired by local initiative. Additionally on the Buri Teesta river (which lies within the Project) a problem of uncoordinated operation of regulators was reported since the Kishorepur and Chilmari regulators are located at either end of this river and when one is closed to keep water out, the other may be open resulting in water draining into that area.

For only one of the water retention structures, under Dinajpur O&M Division was a khalashi found to be working. However, it was notable that he had been successfully working for 30 years - placing fallboards to retain water for irrigation. There is no committee for this structure, but the khalashi is a local person farming some land in the area served by the sluice, and hence with an interest in it functioning properly.

4.4 MAINTENANCE OF PROJECT

4.4.1 Technical Assessment

The current condition of the Project structures was summarised in Table 2.4. In general the regulators are in good condition, although some repairs to gates, replacement of seals, and routine maintenance of the gates and gears is needed. In the case of Kishorepur regulator erosion of the riverside guide bund in 1991 by the Teesta may threaten the regulator itself.

However, embankment maintenance is not adequate. The total length of flood embankment should be 110 km according to the BWDB project documents, but there are a number of openings (cuts and breaches). In addition about two thirds of the total embankment has been occupied by medium to dense development of homesteads on at least one side, and in some places on both riverside and countryside. In general the concentrations of homesteads are near areas with rapid erosion of land on the riverside - for example for several miles around Chilmari ghat. Homesteads on the side slopes of the embankment may cause sufficient damage in some places to contribute to failure in the near future. A majority of the embankment thus has maintenance problems of some sort.

In addition to the public cuts discussed in Section 4.3.1, there are major problems of erosion at a number of sites (see Section 2.4.2). Cuts and breaches have remained in a state of disrepair for years. While the engineers give the lack of funds as the excuse, resources have been available for regulators at some cuts, and resectioning work has been undertaken under FFW. This suggests that BWDB has not reassessed priorities for repairing the Project - there appears to be a bias towards larger works (structures and bank protection), which may mean less efficient use of the limited resources available. No plan assessing the relative benefits and costs of abandoning areas or spending large sums on bank protection was found, and in some cases the area of lower land protected by a stretch of embankment is relatively small (for example near Kawahaga ghat).

4.4.2 Institutional and Social Assessment

What maintenance has been carried out has not been through local initiatives but depends on donor funding - flood damage repair grants and food-for-work wheat. There is a complete lack of routine maintenance, the only maintenance work observed in September 1991 was a team of ten labourers who had been hired for two days to repair raincuts in the embankment in the Harichari regulator area which dated from the previous year (they were being repaired in advance of a visit by the Superintending Engineer).

Just as khalashis receive no specific or general guidance on regulator operation, so they do not receive guidance on simple maintenance of their structures.

There are conflicts between BWDB and the local people over the breaches and cuts in the embankment, the problems are essentially of drainage congestion and inadequate regulators, which reflect a mixture of lack of repairs, and poor maintenance and planning. There has been no move by local people or the local administration to fill in public cuts voluntarily (although they are cut voluntarily). In part this is because there is much more work involved in repairing a cut, in part because drainage congestion may be frequent so people prefer to have an opening rather than repairing it each year in the knowledge that there will be a cut and opening of the same size next year. Yet in the case of the cut at the site of Bamni additional regulator people suffered when the 1988 floods came through the open cut of the previous year. Although they petitioned for a closure they did not repair it themselves.

There is public resentment and conflict over the payment of compensation money for land acquisition, and the legal problem of paying land revenue. On some reaches of embankment the final instalment has not been paid to the landowners. Hence the villagers who lost their land due to acquisition continue to pay land revenue, because BWDB has not yet transferred the ownership titles of the land, even after ten years.

Illegal permanent settlements, which resemble "rural slums", are widespread on the embankment, resulting in damage to the embankment slope and aggravating the maintenance problem. This is a maintenance problem but also a benefit conferred by the embankment which is particularly important close to the Brahmaputra, where river erosion causes major dislocation of human settlements, but in its present unplanned and uncontrolled form is a threat to the embankment.

4.5 O&M STAFFING AND COSTS

There is no historic record of O&M costs, the only figures available being for the immediate past. O&M amounts to the Project establishment, plus food-for-work. In August 1991 there were 79 staff working on Kurigram South Project (including Town Protection) at a monthly cost of Tk 0.35 million or Tk. 4.2 million a year (Tk 66 per ha). This compares with an O&M set up of 87 people outlined in the PP and of 84 people approved by BWDB.

Out of 79 staff 19 per cent are engineers/technical - (comprising 1 XEN, 3 SDEs, 1 Assistant Director, and 10 Section Officers, the latter amount to one per 11 km of embankment (since BWDB is not active in maintaining the drainage channels) - too many for simple monitoring and surveying of the embankment, but insufficient to physically carry out routine maintenance. During four days of travelling along the entire embankment by the FAP 13 team no Section Officers were encountered in the field, despite this being during a peak risk period (early September) and just before a late flood peak in mid-September 1991.

Field staff comprise about 16 per cent of staff: guards are not specified by function, but there are eight functioning regulators in the project each with a khalashi (FAP 13 field work), presumably the remaining 16 are guarding BWDB offices. There are also four full time surveyors, although presumably SOs can survey their sections. Consequently office and administration staff comprise 49 per cent of Project staff, with a further 9 per cent in accounts - presumably mainly accounting for the office staff. There are a further six (7 per cent) in stores and driving pumps although the project has no pumps.

It seems plausible that normal O&M could be managed and carried out by a much smaller establishment so freeing resources for physical maintenance such as materials to keep regulators in order, parts for faulty vertical lift gate gears, and replacement gates. By drastically cutting unproductive staff the Project might run with an establishment of some 50-60 per cent of the present, and even less if khalashi posts become part-time (the regulators are mostly large and so a trained khalashi paid on the basis of work done plus either an honorarium or free house would probably be necessary).

The salary costs which might be freed by this could go, for example, to routine maintenance by women's maintenance teams (see FAP 13 Final Report) - at Tk 25 per person day and a 30 day month this would be a monthly routine maintenance cost of Tk 165,000 assuming two women per km and that all the embankment exists. A 50 per cent cost saving on BWDB establishment costs would be just enough to cover routine maintenance.

However, given the extensive housing development on the embankment, maintenance teams might not be needed for these sections (over 33 per cent of the embankment), if householders can be persuaded to carry out routine maintenance, this would free some resources for work on the much neglected drainage system. In the long term a more sustainable locally resourced programme would be needed (see Section 4.6), this change would reduce the need for resectioning and embankment repair, freeing FFW resources to plug the gaps of cuts and erosion breaches, and for drainage channel re-excavation once these have been surveyed and priorities set.

So far actual embankment maintenance has been through periodic resectioning and rebuilding under FFW programmes. In 1990/91 9.8 km were repaired for Kurigram South and 3.3 km for Kurigram Town Protection, and in 1989/90 13.9 km for Kurigram South and 0.6 km for Kurigram Town Protection. The town protection project may be regarded as integral to the whole project, so total embankment maintenance expenditure has been 446 MT and 14 MT of wheat respectively. If this is typical it indicates expenditure equivalent to Tk 3.8 million in 1987/88 financial prices (FPCO, 1991) per year.

Assuming that basic construction took place between 1973-74 and 1983-84 (at Tk 165.7 million) and that on average a factor of 3.4 times will bring this to a 1987/88 price base (BBS, 1991), then some 1.3 per cent of construction costs may be spent on annual establishment and maintenance costs at present (in constant prices).

4.6 USE OF EMBANKMENTS

In addition to the widespread use of Kurigram South embankment for housing, there is also a good growth of trees and bushes on the embankment, which draws attention to the potential to formalise this use which is currently unplanned and illegal. The present vegetation and potential uses of the embankment are shown in Table 4.1. Carefully cultivated, the plants shown in Table 4.1 could not only stop the present rate of soil erosion, but would also bring economic benefits and create a better environment than the present one. The concept would be to provide an income for poor women from cultivation of bushes and trees for firewood on short duration cycles. This would direct benefits to a disadvantaged group, address an environmental problem, and would be conditional on a requirement to carry out routine maintenance of the embankment - thus saving BWDB O&M resources.

Experiments would be needed with different tree species, densities of planting and micro-habitats. Where an embankment is wider than normal (for example serving a dual purpose as a road) trees might be planted along the edge of the crest, in other cases the side slope might be acceptable, and where there is a berm this might be ideal for trees. Vegetation on the side slope could directly benefit maintenance by protecting against wave action. Trees, bushes and ground cover vegetation are more productive and environmentally preferable to brick mattressing.

The potential costs and benefits of social forestry on embankments would need to be worked out in detail. However, financial costs from the Kurigram area indicate that tree seedlings would be available ex-nursery at Tk 3 each, and that non-labour costs (transport, land preparation and materials) would be another Tk 7-8 each. Initially the costs of paying the women maintenance teams to maintain the embankment and tend the trees would need to come from an external source. In initial experiments this should be subsidised, later it might be a loan repaid out of profits from trees. Assuming that the same two women per km could tend the trees and maintain the embankment may be unrealistic, particularly in the first 1-2 years when there are the maximum number of seedlings to tend so the leasing distances for tree plantations would need to be experimented with. Even with three women per km the initial labour costs would not be high. Supervision of the trees and maintenance would also need to be budgeted for.

Table 4.1 Present and Potential Vegetation of the embankment

LOCATION From	To	Distance (km)	Soil characteristics	Present vegetation	Ecological comments	Suitable Tree for Plantation
Mughalhat regulator	Ratna	22	Sandy	Natural vegetation is lacking. Jiga (*Odinawoodier*) Pineapple are planted by the farmer & growing well.	Erosion is severe and occurs usually in the lean period as a result of movement. To save the embankment from erosion both tree & herbaceous plants could be grown.	Jiga, Shimul & some herbaceous plants
Ratna regulator	Kurigram	14	Sandy silt	Bamboo, Kanthal, Banana, Shimul.	Fruit tree; Neem and fast growing tree could be planted.	Kanthal, Banana Neem, Bakful (fast growing), Shimul
Kurigram	Chilmari	25	Silt sand	Kalmi (*Ipomoea crassicaulis*) Shimul, Banana.	Fruit and mulberry tree could grow & adapt.	Kanthal, Mulberry, Daincha.
Chilmari	Kishorpur	20	Silt sand	Mulberry, Mango	Cultivation is going on.	Mulberry Shimul, Arahar
Kishorpur	Ghariala danga	25	Sandy+silty sand	Not visited	Erosion occurs but not so severe	Mulberry Kanthal Mango

Source: RRA Fieldwork

The critical factor would be the density of planting, for quick returns a high initial density, say 4000 seedlings per km planted in double rows on both embankment sides, could be used, these would be thinned out at the end of 2-3 years (for example by 50 per cent), the next harvest would need to leave say 50 per cent of trees with the others replanted so that the eventual age structure would permit regular cropping and hence a regular income during the year. If this can be achieved then the only drain of the programme on long term resources would be credit and supervision/monitoring to ensure maintenance standards (which would have to be done anyway).

4.7 LESSONS FOR O&M

Erosion and settlement on the embankment is clearly a problem. Planning for social welfare in the face of this should be integral to the project's development plan. Isolating project implementation from a wider development plan (adjusted with changing circumstances) creates an "O&M problem" where a planned embankment settlement programme might benefit people.

Public consultation, as a two way process, is needed to improve the details of project planning (which appears to be an important part of the problem). This might identify alternative alignments or needs for structures. There is virtually no public participation in the Project at any level. It is important to explore ways and means by which local institutions could be associated with managing the Project. There is only likely to be an incentive for such involvement if there are clear benefits from the Project.

There is potential to involve NGOs and government agencies in fully exploiting the potential of the embankment as a forestry resource, and as a source of employment to both distressed men and women. Already Rangpur Dinajpur Rural Services (an NGO) has expressed interest in taking up social forestry on the embankment. They had earlier planted trees on it and handed this back to BWDB, but the programme degenerated due to a lack of maintenance. In future NGOs might be contracted for the O&M of the Project.

Likewise the Project borrow pits are an under-utilised resource. The use of borrow pits should be regulated by the project authority, and those who gain from fish cultivation, for example in the borrow pits, could then bear some responsibility for O&M of the project.

Better use could be made of the resources available for O&M - both in repairing flood damage and responding to the changing problems revealed by floods, and in routine maintenance and establishment staffing. This will require incentives and penalties to encourage management efficiency.

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5 AGRICULTURE

5.1 INTRODUCTION

Before the Kurigram South Project modest areas of cultivated land (about 20 per cent, Chapter 3) were flooded deeply (over 90 cm) in the monsoon. However, during the flood season, the rivers Brahmaputra, Teesta and Dharla periodically overflowed their banks and caused extensive damage to Aus, Aman and jute crops most years. Part of the agricultural land was also lost every year due to bank erosion by these rivers. The eroding pattern, flooding characteristic and sedimentation process of the rivers influenced the formation of the agricultural land of the Project area. In the dry season, there was a severe water scarcity in the area that inhibited the introduction of modern seed-fertilizer technology in agriculture.

Thus, due to inadequate irrigation, flood control and drainage facilities, the agricultural activities in the area were essentially traditional and productivity was low. Paddy was the most important crop occupying more than 80 per cent of the annual cropped land. Local B. Aus, and local T. Aman were the most important paddy crops (grown on more than 74 per cent of cropped land) followed by jute (about 12 per cent of cropped land). Yields were reportedly low: 1.11 mt./ha. for B.Aus and 1.47 mt./ha. for T. Aman (Recast PP, BWDB 1987b, page-22). For identical land types, the cropping patterns were similar over all the area. B. Aus was grown in non-flooded to moderately flooded land and T. Aman, a rainfed crop, was sown in low lands. Boro paddy cultivation was very limited due to moisture deficiency and was only grown in limited low land areas where residual soil moisture was available in the dry season.

The floodplain soils of the Project area (Section 11.1) were generally fertile, but are relatively high in the northern part of the Project. By and large, the area was therefore, double cropped. Nevertheless about one-fourth of the total cultivated land was single cropped, and triple cropping was virtually unknown in the area. Overall, the annual cropping intensity was reportedly 165 per cent during the pre-project period (BWDB, 1976).

The major problems (agricultural and otherwise) of the area were regular floods, soil erosion, drainage congestion and dry-season moisture deficits. These together depressed the overall agricultural activities in the area. Crop damages due to floods had been very high, mean paddy yield rate was low, adoption of HYVs was limited, and the overall regional economy remained stagnant.

5.2 PROJECT OBJECTIVES AND TARGETS

The Kurigram (South Unit) Project was undertaken with multipurpose objectives which included flood control, irrigation and drainage. The Project aimed at meeting the national plan criteria of increasing food production and employment, and reducing poverty through accelerated and intensive agricultural activities in the area. On full completion the Project was expected to:

- prevent monsoon floods and reduce drainage congestion to intensify monsoon crop cultivation;

- provide irrigation facilities to about 28200 ha. by the Barrage (to be constructed across the river Dharla), and to another 20800 ha. by pumping plants (to be installed at the right bank of the Dharla);

- provide a net incremental milled rice production of 159954 metric tons annually;

- increase cropping intensity from 165 per cent to 227 per cent;

- raise employment opportunities in the agricultural sector from 11.40 million mandays (pre-project) to 19.32 million mandays - the annual additional employment generation being 7.92 million mandays; and

- achieve an established net incremental output valued at US $ 25083 (from paddy alone at 1987 world market price) per annum, which would lead to foreign exchange savings (to this extent) by way of import subsitution.

(Recast P.P, BWDB 1987b)

The irrigation component of this Project has not been implemented yet. However, minor irrigation has expanded rapidly in the area since the feasibility study.

5.3 PROJECT IMPACTS ON AGRICULTURE

The Kurigram South Project as implemented might alleviate two major constraints on agriculture: floods and drainage congestion. The present section evaluates the successes (and failures) of the Project in agriculture. The decisive major indicators among others are: changes in cropped area, cropping pattern, extent of HYV paddy cultivation, cropping intensity, crop yield rates, crop production and output, use of crop inputs, and net return from agriculture.

To assess project impacts a 'control' area (comparable to the without project situation) was selected from outside but adjacent to the Project area, to compare with the Project. Part of the Project impacted area comprises villages outside the embankment in the active floodplain which may have been affected by the Project (positively or negatively). The same structured questionnaire was used in the three areas, and the results compared to arrive at "with- and without-project" assessments by including impacted unprotected areas in the overall with-project estimates.

5.3.1 Crops, Cropping Pattern and Cropping Intensity

a) Crop Areas

There are two ways in which an FCD project such as Kurigram South, might change cropped areas: by bringing previously uncultivated areas under cultivation (impact on net cultivated area); and/or by changing the seasons in which land is cultivated (impact on gross cropped area and cropping intensity).

Overall, in the Kurigram Project area there has not been an increase in net cultivated area since most potentially cultivable land in the area was already cultivated in at least one season before the Project was implemented. There have, however, been changes in the incidence of seasonal cropping. Compared with the pre-project situation the area cultivated in the Aus season has fallen from 86 per cent (BWDB, 1987b estimate) to 55 percent (PIE estimate); while it has gone up from 70 percent to 80 percent in the Aman season and from a mere 8 per cent to 55 per cent in the Boro season (Table 5.1). Aus season cropping has decreased because more and more Boro crops, specially the more profitable HYV Boro, are now being cultivated in the Project area, and the seasons overlap each other. The same reasoning is also relevant for the impacted-unprotected area where only 36 per cent of arable lands are cultivated in the Aus season while it is 70 per cent in the Boro season (Table 5.2).

However, keeping the pre- and post-Project comparison aside, in the Project impacted-protected area more land is cultivated in the Aus season compared either with the impacted-unprotected area (+19 per cent), or with the control area (+11 per cent). This suggests that the embankment has been successful in protecting this crop from flood damages. The suggestion is further strengthened by the fact that the yield rate of B. Aus LV, the season's major paddy crop for all the three areas, is higher in the impacted-protected area compared to the other two areas (See Section 5.3.2).

Aman is the most important season for all the three areas. Most of the arable lands are cultivated in this season. The percentage of land cultivated in the season and the cropping pattern are more or less the same in all the areas. However, together with the other land classes, most of the "very low" lands (68 per cent) are cultivated in the impacted-protected area in this season while most of them are left fallow in the impacted-unprotected area (100 per cent) and in the control area (83 per cent), which signifies that the embankment has reduced flood depths in the area effectively. Compared to the pre-project situation, however, land cultivated in the season has gone up from 70 per cent (BWDB, 1987b estimate) to 80 per cent (PIE estimate). This also reflects the success of the Project in protecting crops from monsoon flood damages, as well as of reduced flood depths.

Although expansion of Boro does not always imply an increase in winter cropping intensity, this has been the case with the Kurigram area. As has been indicated earlier, Boro cropping intensity has increased manyfold (more than 6 times) in the Project impacted area, compared to the pre-project situation (see Table 5.1). The increase has been basically in HYV Boro. Compared with the control area the intensity in the impacted area is only marginally higher (51 per cent against 48 per cent). Boro crops depend mainly on the availability of irrigation water. Small scale irrigation has expanded simultaneously in both areas during 1973/74-1991, as few household in either area had irrigation before that time, yet as Section 3 shows ground water irrigation is now widespread.

The Project's irrigation component has not been installed, but there has been significant expansion of private minor irrigation (mainly STWs). Hence, the Boro benefits are **not** attributable to the Project, particularly as the three main rivers flowing in the area flood after the Boro season. However, one unintended negative impact of the Project has, very interestingly, turned into a positive impact for Boro crops in the Project area. The Project intended to improve drainage but has not yet achieved it, rather the embankment has resulted in more drainage congestion. The prevailing drainage congestion now has resulted in increasing soil moisture in the dry season, which, in turn, is used for Boro cultivation.

Table 5.1 Crops and Crop Areas: Pre- and Post-Project Percentage Distribution of Net Cultivable Land

Crops	Pre-Project	Post-Project	Difference (Post - Pre)
Aus Season			
B. Aus LV	61.2	21.8	-39.4
T. Aus LV	-	0.8	+0.8
T. Aus HYV	5.3	5.7	+0.4
B. Aus+Aman mixed	-	0.7	+0.7
Jute	19.7	25.8	+6.1
Others	0.6	0.4	-0.2
Sub-total: Aus season	**86.8**	**55.2**	**-31.6**
Aman Season			
B. Aman LV	0.5	0.6	+0.1
T. Aman LV	61.2	67.9	+6.7
T. Aman HYV	8.2	11.1	+2.9
B. Aus+Aman mixed	-	0.7	+0.7
Sub-total: Aman Season	**69.9**	**80.3**	**+10.4**
Boro/Rabi Season			
Boro LV	-	0.7	+0.7
Boro HYV	0.5	36.7	+36.2
Wheat	4.1	5.0	+0.9
Potato	0.8	5.2	+4.4
Oilseeds	0.2	-	-0.2
Others[1]	2.6	7.4	+3.3
Sub-total: Boro/Rabi Season	**8.2**	**55.0**	**+46.8**
Cropping Intensity (%)	165	190	+25

Source: Pre-Project - Estimated from Recast PP, BWDB 1987b, p-22
Post-Project - FAP 12 PIE Household Survey

Note: [1]Includes perennial sugarcane and betel leaf

Table 5.2 Percentage Distribution of Cultivable Land by Level and Crop

Crops	Impacted Protected						Impacted-Unprotected						Control					
	H	MH	ML	L	VL	All levels	L	MH	ML	L	VL	All levels	L	MH	ML	L	VL	All levels
Aus Season																		
B. Aus LV	21.4	22.3	17.8	21.5	77.2	21.8	14.7	42.5	17.7	16.1	-	19.5	25.5	14.4	9.6	19.5	34.4	21.5
T. Aus LV	1.3	-	-	1.7	-	0.8	-	-	-	-	-	-	1.2	-	-	-	-	0.7
T. Aus HYV	3.9	15.7	3.4	4.3	-	5.7	-	-	-	2.0	-	1.0	1.6	8.1	-	-	-	2.3
B. Aus+Aman mixed	-	2.0	1.4	-	-	0.7	-	-	-	-	-	-	-	-	-	-	-	-
Jute	28.9	30.4	21.6	18.8	2.8	25.8	-	48.3	8.8	13.8	-	15.9	24.2	17.1	14.6	11.7	6.3	19.8
Vegetables and others	0.9	-	-	-	-	0.4	-	-	-	-	-	-	-	-	-	-	-	-
Sub-total: Aus season	**56.4**	**70.4**	**44.2**	**46.3**	**80.0**	**55.2**	**14.7**	**90.8**	**26.5**	**31.9**	**-**	**36.4**	**52.5**	**39.6**	**24.2**	**31.2**	**40.7**	**44.3**
Aman Season																		
B. Aman LV	-	1.9	0.9	-	5.5	0.6	53.3	-	-	49.3	-	29.1	5.5	-	-	-	-	3.1
T. Aman LV	63.1	71.9	82.6	52.7	62.8	67.9	13.3	60.0	19.3	28.4	-	28.3	78.8	85.4	78.9	46.8	17.0	74.3
T. Aman HYV	12.0	22.4	7.6	-	-	11.1	9.3	17.5	60.8	-	-	17.0	4.1	11.4	-	-	-	4.3
B. Aus+Aman mixed	-	2.0	1.4	-	-	0.7	-	-	-	-	-	-	-	-	-	-	-	-
Sub-total: Aman Season	**75.2**	**98.2**	**92.5**	**52.7**	**68.3**	**80.3**	**75.9**	**77.5**	**77.1**	**77.7**	**-**	**74.4**	**88.4**	**96.8**	**78.9**	**46.8**	**17.0**	**81.7**
Boro/Rabi Season																		
Boro LV	-	-	0.8	4.8	-	0.7	-	-	-	-	-	-	-	-	-	11.8	26.5	2.4
Boro HYV	35.9	24.0	44.4	45.1	20.0	36.7	-	-	51.9	18.1	100.0	25.1	23.8	20.8	56.6	46.3	32.0	29.0
Wheat	5.6	3.5	1.7	12.3	-	5.0	8.0	0.1	5.0	4.0	-	5.1	10.9	4.5	1.9	3.2	-	7.2
Potato	11.09	-	-	-	-	5.2	-	-	-	-	-	-	2.6	-	-	-	-	1.4
Oilseeds	-	-	-	-	-	-	10.7	-	-	38.9	-	20.1	3.7	-	-	-	-	2.0
Others	4.5	4.5	0.1	3.1	11.0	3.5	68.0	18.3	14.4	15.8	-	20.0	9.5	1.9	7.6	1.0	-	6.4
Sub-total:Boro/Rabi Season	**57.1**	**32.0**	**47.0**	**65.3**	**31.0**	**51.1**	**86.7**	**18.4**	**71.3**	**76.8**	**100.0**	**70.3**	**50.5**	**27.2**	**66.1**	**61.3**	**58.5**	**48.4**
Perennial																		
Betel Leaf	0.1	-	-	-	-	0.1	-	-	-	-	-	-	-	-	-	-	-	-
Sugarcane	2.6	-	-	-	-	1.2	-	-	-	-	-	-	-	-	-	-	-	-
Total Cultivable Land (ha.)	**34.81**	**11.89**	**17.49**	**8.29**	**1.45**	**73.93**	**0.75**	**1.20**	**1.81**	**3.98**	**0.38**	**8.12**	**39.97**	**12.36**	**7.26**	**8.38**	**2.53**	**70.50**
Total Cropped Land (ha.)	68.05	23.92	32.12	13.63	2.60	140.32	1.37	3.31	3.22	7.42	0.38	14.73	75.66	20.21	12.29	11.75	2.94	122.85
Percentage cultivable land	47%	16%	24%	11%	2%	100%	9%	15%	22%	49%	5%	100%	57%	18%	10%	12%	4%	100%
Cropping Intensity (%)	195	201	184	164	179	190	183	187	178	186	100	186	189	164	169	140	116	174

Source: FAP 12 PIE Household Survey

Note: L = High Land (flood free), MH = Medium High Land (flooding up to 1'), ML = Medium Low Land (flooding 1'-3'), L = Low Land (flooding 3'-6'), VL = Very Low Land (flooding 6'+)

Overall, reduced flood depths and duration due to the embankment do appear to have had an important, though not dramatic, impact on Aus and Aman crops. For example, in 1987 and 1988 (two flood years), yields of the main monsoon crops were substantially higher in the Project area than the same crops in the control area (see Section 10.7.2).

b) Cropping Pattern

Paddy dominates the cropping pattern in both the Kurigram Project and control areas. It occupies about 80 per cent of the annual gross cropped land in both the areas. The next most important crop is jute which occupies 14 per cent of the annual gross cropped land in the Project area and a little more than 11 per cent in the control area (Table 5.3). The relative position of paddy and jute within the cropping pattern was very similar even before the Project was implemented (P.P., BWDB 1987b). Thus, the Project does not seem to have created any impact on the overall cropping pattern of the area.

Within the paddy cropping pattern apparently there has not been any significant varietal change due to the Project. The pattern is almost the same in the impacted and the control areas. Only in the cases of T HYV Aus and T HYV Aman, is more land cultivated in the impacted area compared to the control, but the areas under the crops are too small to draw any firm conclusion. Moreover, pre-project, similar areas were also under the same crops (Table 5.3).

However, compared with the pre-project situation, there has been a dramatic change in HYV Boro cultivation in the Project area (but not so dramatic if compared with the control area). Pre-project, the crop was almost unknown in the area, but now that minor irrigation facilities have spread (both in the impacted and the control areas) people have shifted a significant proportion of their land from Aus to HYV Boro, as the latter brings more yield and more profit. This is not a Project impact. The areas and types of other dry season crops (basically the rabi crops) have remained, more or less, similar to the pre-project situation (Table 5.3).

The Project was expected to result in a major shift from local B. Aus and jute to T. HYV Aus; and from local T. Aman to T. HYV Aman (BWDB,1987b) as the Project would reduce flood depths and durations and thus provide greater security to these dwarf crops against fluctuations in water levels. But the expectation has remained largely unachieved. This is mainly because the drainage component of the Project has not yet been implemented. Siltation of khals and failure to excavate a drainage network, plus inadequate drainage capacity at some sites has resulted in water logging, along with many public cuts and breaches. This means that monsoon conditions are not so improved as to enable a cropping pattern change.

c) HYV Paddy Adoption

Although this has not been mentioned specifically in the Kurigram Project Proforma, one of the main objectives of any FCD/I project has been to induce an expansion of high yielding varieties of paddy over all seasons and thus increase production. However, for reasons discussed above there has been little such change as a result of the Kurigram Project.

Table 5.3 Cropping Pattern (% of Gross Cropped Land)

Crops	Impacted (Protected)	Impacted (Unprotected)	Control	Pre-project[1]	Target[1]
B. Aus LV	11.7	10.5	12.3	37.0	8.1
T. Aus LV	0.4	-	0.4	-	-
T. Aus HYV	3.0	0.5	1.3	3.2	16.1
Jute	14.0	8.5	11.4	11.9	5.7
B. Aus/Aman mixed	0.4	-	-	-	-
B. Aman LV	0.3	15.6	1.8	0.3	-
T. Aman LV	36.5	15.2	42.6	37.0	17.9
T. Aman HYV	5.9	9.1	2.5	5.0	23.1
Boro LV	0.4	-	1.4	-	-
Boro HYV	19.7	13.5	16.6	0.3	4.6
Wheat	2.7	2.7	4.2	2.5	4.6
Potato	2.8	-	0.8	0.5	3.5
Others	1.7	24.4	4.7	2.1	15.9
Sugarcane/Betel Leaf	0.5	-	-	0.2	0.5
Total (%)	100.0	100.0	100.0	100.0	100.0
Gross Cropped area (ha.)	137.6	15.09	122.85	80800	111500

Source: FAP - 12 PIE Household Survey
Note: [1]Recast PP, 1987

By and large more HYVs are cultivated in the impacted area compared to the control area in all seasons - Aus, Aman and Boro. Overall, HYVs occupy 37 percent of the annual paddy cropped land in the impacted area against 26 per cent in the control (Table 5.4). The higher percentage of land use under T. Aus HYV and T. Aman HYV, compared to the control, may lead one to infer that the difference is due to the Project as it now protects the crops from monsoon flood damages. Such a conclusion in the case of Kurigram would be misleading on two counts. Firstly because land areas under these two HYV crops are very small compared to the local varieties; and secondly because a similar proportion of land had been under these crops even before the Project was completed (See Recast P.P., BWDB 1987, and Table 5.4). There has been a dramatic increase in HYV Boro cultivation compared to pre-project situation, but this has not been due to the Project.

d) Cropping Intensity

The annual cropping intensity in the impacted area is higher than in the control area (190 per cent against 174 per cent). The intensity is somewhat higher in the Aus season (+11 per cent), and marginally higher in the Boro season (+3 per cent), while in the Aman season it is almost the same (around 80 per cent) in both the areas. There are small Project difference for paddy: Boro being 6 per cent higher and Aus 5 per cent higher. These marginal differences, however, do not signify much Project impact on cropping intensities. What is important to notice is that a substantially higher proportion of 'low' and 'very low' classes of lands are cultivated in the impacted area compared to the control for Aus paddy (+8 per cent and +43 per cent respectively) and for Aman paddy (+6 per cent and +51 per cent respectively), see Table 5.2. In the control area these lands are mainly under Boro. This suggests that the Project has been successful in reducing flood depths and durations in the Project area.

Table 5.4 HYV Paddy Adaption

	% of Cultivated Land for Paddy				% of Gross Cropped Land			
	Impacted (Protected)	Impacted (Unprotected)	Control	Pre-Project[1]	Impacted (Protected)	Impacted (Unprotected)	Control	Pre-Project[1]
T. Aus HYV	3.9	0.8	1.7	3.9	3.0	0.5	1.3	3.2
T. Aman HYV	7.6	14.2	3.1	6.0	5.9	9.1	2.5	5.0
Boro HYV	25.2	20.9	21.1	0.4	19.7	13.5	16.6	0.3
All HYVs (%)	36.7	35.9	25.9	10.3	28.6	23.1	20.4	8.5
Total Land (ha.)	107.96	9.74	96.94	67100	137.6	15.09	122.85	80800

Source: FAP 12 PIE Survey
Note: [1]Recast PP, 1987

Compared to the pre-project situation, however, there has been a considerable increase in the annual cropping intensity in the Project area (from 165 per cent to 190 per cent), although the target intensity of 227 per cent (BWDB, 1987b) is yet to be achieved. However, the present increased intensity is related both to the Project (particularly for increased Aus season intensity) and to the autonomous expansion of private minor irrigation facilities (particularly for Boro HYV paddy intensity). The contribution of the two towards seasonal intensity changes may overlap each other and is difficult to separate.

5.3.2 Crop Yields

Increases in mean yield following flood protection and expansion of irrigation (either as an integral component of the FCD project or otherwise) arise mainly from three factors: a switch to transplanted varieties and/or to HYVs; increased use of inputs given lower perceived risk of crop failure; and reduced annual or periodical losses due to floods. In Kurigram the latter two have been identified as significant (compared to the control area). The first, that is varietal change, has been found significant only for HYV Boro which cannot be regarded as a Project impact.

However, mean input use, particularly of fertilizers (both chemical and organic), insecticides and irrigation, is higher in the impacted area. All these together have raised the per hectare paddy yield considerably. The protected area now harvests 2.78 mt./ha. (weighted average over all seasons), against 2.19 mt./ha. in the control area, and the pre-project 1.55 mt./ha. (Table 5.5). All the paddy crops, in every season, now reap higher yields, ranging from an additional 0.46 mt./ha. in local B. Aus to 1.33 mt./ha. extra for HYV Boro, compared to the pre-project yield rates. The monsoon crop yields, particularly of B. Aus LV, and T. Aman LV (the two most important crops for all the areas), are higher in the impacted area compared to the control area, which suggests that the FCD embankment has been successful in protecting these crops from flood damages. The crops were vulnerable to monsoon floods previously. However, the overall expected yield rate (3.10 mt./ha.) has not yet been achieved (although HYV yields are as predicted). The original target for B. Aus (2.58 mt./ha.) appears unattainable and impractical.

Table 5.5 Per Hectare Crop Yields (mt.), Kurigram South

Crops	Impacted (Protected)	Impacted (Unprotected)	Control	Pre-Project[1]	Targeted[2]
Paddy Crops					
B. Aus, LV	1.57	0.76	1.28	1.11	2.58
T. Aus, LV	0.25	-	5.03	-	-
T. Aus, HYV	3.89	3.29	4.04	2.3	3.69
B. Aus/Aman, Mixed	2.61	-	-	-	-
B. Aman, LV	2.24	0.93	2.61	1.29	
T. Aman, LV	2.24	1.83	1.95	1.47	2.21
T. Aman, HYV	3.54	3.62	3.39	2.76	3.41
Boro LV	1.63	-	2.18	-	-
Boro HYV	4.28	3.58	3.04	2.95	3.87
All Paddy (weighted av.)	**2.78**	**2.07**	**2.19**	**1.55**	**3.10**
Non-paddy Crops					
Jute	1.50	1.23	1.39	1.38	1.47
Wheat	1.65	1.45	1.78	1.38	2.21
Potato	13.39	-	6.26	7.37	11.00
Pulses	0.23	-	0.71	0.55	0.92
Oilseeds	-	1.22	0.40	0.55	0.92
Winter vegetables	6.70	-	8.69	4.61	7.37
Sugarcane	32.4	-	-	23.00	36.86
Others	2.69	1.83	2.58	-	-

Source: FAP - 12 PIE Household Survey
Note: [1]Recast PP, 1987 without project estimates
[2]Recast PP, 1987 with project estimates

In view of achieving higher annual mean paddy yields it was expected at the inception of the Project that there would be a considerable change in monsoon cropping pattern, particularly in favour of higher yielding T. Aus and T. HYV Aman as the embankment would provide greater security against fluctuations in water levels during monsoon (BWDB, 1987b, Tables in pages 22, 23). But this has not happened (see Table 5.3). HYVs require higher input costs than the traditional local varities, and being dwarf in size, are also more vulnerable to fluctions in water depths and durations. The deteriorated drainage and water logging conditions now existing within the embankment threaten their safe harvest. People, therefore, are averse to the risk of cultivating these crops, and it is not clear from PIE data from one year whether the annual average yield of HYVs would be higher than for local T. Aman where T L Aman is grown.

The impact of the Project (positive or negative) in case of non-paddy crops is not clear. The yield rate of jute is slightly higher in the impacted area than in the control area (+0.11 mt./ha.), the same is true for potatoes. In the case of wheat, pulses and winter vegetables the yields are higher in the control area. However, the differences are not significant and are not related with the Project.

5.3.3 Crop Production and Output

As indicated earlier paddy is by far the most important crop in Kurigram South. Compared with the control area the impacted area produces on average 27 per cent more paddy per hectare annually. However, all of this gain cannot be attributed to the Project infrastructure alone. The expansion of HYV Boro cultivation and its yield rate (4.28 mt./ha.) contributes significantly to the annual production. This Boro benefit is associated largely with the autonomous expansion of minor irrigation facilities. Ignoring HYV Boro yields, the mean yield rate drops down to 2.3 mt./ha. (from 2.78 mt./ha.) in the Project area. From monsoon paddy crops (Aus and Aman) the impacted area harvests a marginally higher average yield per hectare (+0.35 mt./ha.) than the control area. This may be directly related to the Project's benefit of reduced flood damages. Had the controlled drainage system been developed fully, together with the embankment, people might have cultivated more HYV Aus and Aman crops, instead of lower yielding local varieties, which would increase the mean yield rate and therefore total production further. It is precisely for this that the target of an annual mean yield to the tune of 3.10 mt./ha. could not be achieved. Table 5.6 shows the actual yields per ha. of the main paddy crops recorded in 1990-91 from the surveys.

Table 5.6 Paddy Crops and Output from PIE Sample Surveys

Paddy	Impacted			Control			Yield difference/ha.	
	Cultivated land (ha.)	Total output (mt.)	Yield/ha. (mt.)	Cultivated land (ha.)	Total output (mt.)	Yield/ha. (mt.)	mt.	%
B. Aus LV	16.12	25.31	1.57	15.16	19.40	1.28	+0.29	+23
T. Aus LV	0.60	0.15	0.25	0.46	2.31	5.03	-4.78	-191
T. Aus HYV	4.18	16.26	3.89	1.63	6.59	4.04	-0.15	-4
B. Aus/Aman mixed[1]	0.54	1.41	2.61	-	-	-	-	-
B. Aman LV	0.47	1.05	2.24	2.19	5.72	2.61	-0.37	-17
T. Aman LV	50.23	112.52	2.24	52.38	102.14	1.95	+0.29	+15
T. Aman HYV	8.16	28.89	3.54	3.04	10.31	3.39	+0.15	+4
Boro LV	0.54	0.88	1.63	1.66	3.62	2.18	-0.55	-34
Boro HYV	27.12	116.42	4.28	20.42	62.08	3.04	+1.24	+41
All Paddy Crops	107.96	302.89	2.78	96.94	212.17	2.19	+0.59	+27
Jute	19.04	28.56	1.50	13.95	19.39	1.39	+0.11	+8

Source: FAP 12 PIE Household Survey
Note: [1]For yield rate estimate the land under the crop is considered for either of the seasons.

Total output change is influenced by reduced flood damages, varietal changes in favour of HYVs and intensity changes. The Kurigram Project has had little impact on the latter two. Flood damages have been reduced considerably. Overall, however, there has been an increase in paddy output in the impacted area. The 'with' project estimates show an increase of 53241 mt. of paddy per annum in the impacted area over the 'without' project estimates (Table.5.7). Table 5.2 showed that similar areas are under HYV Boro in both Project and control areas, it is assumed that the non-Project related expansion of small-scale irrigation took place in both areas, so, the irrigation components is aggregate paddy output cancel out each other. Hence the increased output may be considered as a Project benefit. However, this incremental paddy output is only one-fifth of the targeted annual incremental output (1,59,954 mt. milled rice, or 2,63,924 mt. paddy). The target could not be achieved partly because the extensive surface irrigation system was not implemented, but also because cropping intensity has not attained its target, and monsoon cropping pattern changes in favour of HYVs were limited. The limitations have already been highlighted in Sections 5.3.1 (b), 5.3.1 (d) and 5.3.2.

Table 5.7 Paddy Output: With and Without Project Estimates

	Output (mt.)
With Project	203913
Without Project	150672
Difference	+53241
% Change	+35.3

Note: The estimates are made by extrapolating per hectare annual paddy yields by the total annual paddy cropped land area of the Project.

5.3.4 Crop Production Inputs

It has already been seen that Kurigram South has achieved considerable success in protecting monsoon crops from flood damages; and the autonomous expansion of irrigation has made irrigation water available in the dry season for cultivation, particularly, for HYV Boro. As a result farmers in the Project area spend about Tk. 800 more per hectare, as an weighted average, for paddy production than their counterparts in the control area. The impacted area farmers use about 10 per cent more chemical fertilizers, about 87 per cent more organic manure, and 36 per cent more pesticides, but also spend about 30 per cent more on irrigation costs, on average (Table 5.8). The explanation is primarily that a higher percentage of land in the Project area is under HYV Aus and HYV Aman, and these crops have relatively high input requirements. Comparing crop varieties there is little difference in input use or total cost of inputs between Project and control areas (Table 5.8), with the exception of HYV Aman, however, this reflects differences in input levels and apparent cultivation practices. There does appear to be a more consistent difference between the protected and unprotected impacted areas (although the latter is based on a small sample). Input levels tend to be lower in the unprotected areas (Table 5.8) which are more risky since they lie in the active floodplains adjacent to the Project. The net return from the widely cultivated local T Aman is about Tk. 2000 more per hectare in the impacted area compared with the control area reflecting yield differences rather than cost of production differences.

5.3.5 Value of Crop Output and Net Return

The annual aggregate net output value of paddy crops, including the value of by-products, is about 34 per cent higher in the impacted protected area than the control area. The cost and return ratio is 1:2.4 in the impacted area against 1:2.15 in the control area. If HYV Boro is excluded (as explained earlier, changes in the crop cannot be related to the present FCD Project), then the impacted area has a net return of Tk. 1700 more than the control area from Aus and Aman paddy crops, in aggregate. For these crops in the impacted area costs of production are Tk. 553 more per hectare, on average. However, the proportionate increase in output value is considerably higher than the increase in input costs. The incremental cost and return ratio is 1:3, indicating better returns to production inputs in the protected area. This may be a result of protection from flood damages.

However, returns have only been better in the impacted area in the cases of long-stem local broadcast Aus, local transplanted Aman and mixed Aus+Aman among the monsoon paddy crops in the survey year (1990). 1990 was a typical normal flood year, yet in this year the net return of T HYV Aus and T HYV Aman was marginally smaller in the impacted area compared to the control area (Table 5.9). Small differences in yield and input costs appear to cancel each other out. It seems likely that these crops are only grown in the most favourable sites in both areas and hence in a normal year returns are similar. It would be necessary to investigate years of extreme floods and and high rainfall to determine whether there are more flood damages in the control area, or whether HYV Aus and Aman in the Project have expanded into areas at risk of drainage congestion (the indications are that their adoption has been limited by this problem).

Table 5.8 Crop Production Input Use per Hectare

Crops	Impacted Protected							
	Seeds/ seedlings (Tk.)	Human labour (m-d)[1]	Animal labour (p-d)[2]	Chemical Fertilizer (kg.)	Manure (md)	Pesti-cide (kg.)	Irrigation water (Tk.)	Total input cost (Tk.)
Paddy Crops								
B. Aus LV	586	150	25	88	66	1.0	26	5151
T. Aus LV	639	241	59	34	17	1.4	-	8183
T. Aus HYV	446	292	32	217	59	2.7	3294	11821
B Aus/Aman mixed	947	125	9	62	-	3.6	-	4503
B. Aman LV	777	188	37	95	63	-	-	6617
T. Aman LV	592	185	23	145	25	0.5	47	5766
T. Aman, HYV	545	253	31	165	34	3.0	385	7911
Boro, LV	446	81	22	15		-	1122	4053
Boro, HYV	770	237	26	363	63	3.0	4894	13279
All Paddy Crops	629	202	25	194	43	1.5	1418	7960
Non-paddy Crops								
Jute	503	230	27	111	42	0.1	-	6412
Wheat	1480	81	27	167	57	-	182	6948
Potato	4383	225	32	457	26	2.5	-	12897
Oilseeds	-	-	-	-	-	-	-	-
Other Rabi Crops	5728	390	35	283	24	-	-	17606
Sugarcane	6401	246	19	450	134	5.6	-	15961
Betel Leaf	4940	3754	-	-	62	-	-	65270

Crops	Impacted Unprotected							
	Seeds/ seedlings (Tk.)	Human labour (m-d)[1]	Animal labour (p-d)[2]	Chemical Fertilizer (kg.)	Manure (md)	Pesti-cide (kg.)	Irrigation water (Tk.)	Total input cost (Tk.)
Paddy Crops								
B. Aus LV	554	133	22	49	-	-	-	4108
T. Aus LV	-	-	-	-	-	-	-	-
T. Aus HYV	446	63	36	114	-	7.5	7560	14311
B Aus/Aman mixed	-	-	-	-	-	-	-	-
B. Aman LV	620	136	10	35	-	-	-	3641
T. Aman LV	479	190	21	72	33	0.9	-	5242
T. Aman, HYV	573	259	20	166	14	1.6	-	6682
Boro, LV	-	-	-	-	-	-	-	-
Boro, HYV	398	216	18	253	-	2.3	4813	10994
All Paddy Crops	521	182	18	111	10	1.0	1070	6153
Non-paddy Crops								
Jute	440	198	26	16	-	0.1	-	5053
Wheat	2024	232	28	174	48	-	1586	9922
Potato	-	-	-	-	-	-	-	-
Oilseeds	785	202	15	-	-	-	-	5007
Other Rabi Crops	1537	213	22	2	-	0.7	-	6142
Sugarcane	-	-	-	-	-	-	-	-
Betel Leaf	-	-	-	-	-	-	-	-

Crops	Control							
	Seeds/ seedlings (Tk.)	Human labour (m-d)[1]	Animal labour (p-d)[2]	Chemical Fertilizer (kg.)	Manure (md)	Pesti-cide (kg.)	Irrigation water (Tk.)	Total input cost (Tk.)
Paddy Crops								
B. Aus LV	693	163	22	83	22	0.3	-	5170
T. Aus LV	1123	399	25	437	-	-	8982	19755
T. Aus HYV	957	186	32	309	17	1.8	4457	11883
B Aus/Aman mixed	-	-	-	-	-	-	-	-
B. Aman LV	447	145	19	84	-	-	-	4071
T. Aman LV	588	184	22	137	17	0.2	-	5521
T. Aman, HYV	768	177	28	294	16	1.3	-	6823
Boro, LV	599	234	19	93	-	-	1265	7044
Boro, HYV	788	245	23	336	46	2.0	4518	12520
All Paddy Crops	658	194	22	177	23	1.1	1089	7149
Non-paddy Crops								
Jute	527	196	26	119	25	-	-	5795
Wheat	1410	146	27	222	16	-	121	6564
Potato	5033	241	30	198	51	0.5	-	24294
Oilseeds	176	92	22	161	71	-	-	-
Other Rabi Crops	89	163	23	36	7	-	-	4107
Sugarcane	-	-	-	-	-	-	-	-
Betel Leaf	-	-	-	-	-	-	-	-

Source: FAP - 12 PIE Household Survey
Note: [1]m-d man-days, [2]p-d pair-days

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Overall, the net return from all crops, paddy and non-paddy, is higher in the impacted area (Tk. 11600/ha.) than the control area (Tk.8700/ha.). While common crops are produced in both the areas, the impacted area shows the highest relative return for potato (among non-paddy crops) and from HYV Boro followed by local B Aus and T Aman, LV (among paddy crops). Among other common crops the control area has a higher differential net return for local T Aus and B Aman, HYV T Aus and T Aman, and Boro LV, among the paddy crops, and for wheat and winter vegetables among the non-paddy crops. However, most of these are minor crops for both the areas, their contributions (positive or negative) towards gross returns from the agricultural sector as a whole are negligible. In aggregate, farmers in the impacted area enjoy about Tk. 2,900 more in net returns per hectare of cultivated land at 1990-91 local prices. This is effectively the combined benefit of private irrigation equipment (mostly STWs) for HYV Boro, and the public embankment for T LV Aman.

It should be noted that in estimating the output values the same prices have been used for the impacted-protected, impacted-unprotected and the control areas, to avoid possible distortion of the comparison. Family labour and family animal labour have been costed at the local market rates.

5.4 CONCLUSIONS

5.4.1 Summary of Findings

Compared with the pre-Project situation the overall agricultural situation of the Kurigram South Project area has undergone significant changes over time. All of these changes cannot be related with the Project. Some of them are autonomous and have taken place in the control area simultaneously. The most important among them is the rapid expansion of irrigation. Minor irrigation equipment, particularly STWs, has been installed by the private sector, and with government subsidies, to a large extent in both the areas. The Project has had nothing to do with this expansion of irrigation.

The expansion of irrigation has greatly increased the area of HYV Boro in both the Project and control areas alike. If the embankment has had any impact on this, it must be only marginal, in sofar as it now ensures a safer harvest inside. However, this is again unlikely to be a benefit as the three main rives adjacent to the Project generally flood after the Boro season.

However, the Project has had some success in protecting the monsoon crops (particularly the long-stem local ones) from flood damages which is consistent with the purpose for which the embankment was constructed. The weighted mean yield of all types of monsoon paddy (Aus and Aman) is little more than 2.3 mt./ha., which is 0.35 mt. higher than the average of 1.96 mt./ha.in the control area. Overall the mean paddy yield (inclusive of Boro) is about 0.6mt./ha. higher in the impacted area compared with the control, and about 1.23 mt./ha. compared with the pre-project yield. Hence HYV Boro has expanded more in the Project area, but the only link with the Project was the residual moisture left by drainage congestion in part of the Project. The paddy cropping intensity is only about 9 per cent higher in the Project than in the control area. The overall cropping intensity is 16 per cent higher than in the control area; and 25 per cent higher than pre-project. The monsoon crop yield increase is essentially due to the comparatively higher yields of local broadcast Aus and local transplanted Aman, the two major crops of the area. The higher yield from these crops is a direct benefit of the embankment. The embankment now protects the crops from flood damages.

Table 5.9 Per Hectare Cost of Production, Yield and Net Return

Crops	Impacted Protected area					Impacted unprotected area					Control Area					Differences in net returns (Imp.-Cont.) (Tk. '00)
	Crop Yield (mt.)	By-products (mt.)	Total cost (Tk.'00)	Gross Return (Tk.'00)	Net Return (Tk.'00)	Crop Yield (mt.)	By-products (mt.)	Total cost (Tk.'00)	Gross Return (Tk.'00)	Net Return (Tk.'00)	Crop Yield (mt.)	By-products (mt.)	Total cost (Tk.'00)	Gross Return (Tk.'00)	Net Return (Tk.'00)	
Paddy Crops																
B. Aus LV	1.57	3.14	52	117	65	0.76	1.52	41	58	17	1.28	2.56	52	95	43	+22
T. Aus LV	0.25	0.50	82	22	(-)60	-	-	-	-	-	5.03	10.06	198	442	244	-304
T. Aus HYV	3.89	3.89	118	239	121	3.29	3.29	143	176	33	4.04	4.04	119	248	129	-8
B. Aus/Aman mixed	2.61	5.22	45	198	153	-	-	-	-	-	-	-	-	-	-	na
B. Aman LV	2.24	4.48	66	224	158	0.93	1.86	36	93	57	2.61	5.22	41	261	220	-62
T. Aman LV	2.24	4.48	58	173	115	1.83	3.66	52	141	89	1.95	3.90	55	150	95	+20
T. Aman HYV	3.54	3.54	79	236	157	3.62	3.62	67	242	175	3.39	3.39	68	226	158	-1
Boro LV	1.63	3.26	41	121	80	-	-	-	-	-	2.18	4.36	70	162	92	-12
Boro HYV	4.28	4.28	133	251	118	3.58	3.58	110	180	170	3.04	3.04	125	178	53	+65
All paddy (weighted Av.)	2.78	4.30	80	191	111	2.07	2.85	62	139	77	2.19	3.56	72	155	83	+28
Non-paddy Crops																
Jute	1.50	3.00	64	174	110	1.23	2.46	51	143	92	1.39	2.78	58	161	103	+7
Wheat	1.65	-	69	80	11	1.45	-	99	70	(-)29	1.78	-	66	86	20	-9
Potato	13.39	-	129	359	230	-	-	-	-	-	6.26	-	243	168	(-)75	+235
Pulses	0.23	-	23	15	(-)8	-	-	-	-	-	0.71	-	27	47	20	-28
Oilseeds	-	-	-	-	-	1.22	-	50	137	87	0.40	-	38	42	4	na
Winter vegetables	6.70	-	115	628	513	-	-	-	-	-	8.69	-	216	815	599	-86
Sugarcane	32.40	-	160	330	170	-	-	-	-	-	-	-	-	-	-	na
Others	2.69	-	176	360	184	1.83	-	61	171	110	2.58	-	41	346	305	-121
Net Return from non-paddy crops/ha.	-	-	-	-	136	-	-	-	-	87	-	-	-	-	102	+34
Net Return from Agri./ha.	-	-	-	-	116	-	-	-	-	81	-	-	-	-	87	+29

Source: FAP - 12 PIE Household Survey

Note: na - Not available

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However, the expected change in the monsoon cropping pattern, in favour of HYVs, could not be achieved at all. Water levels have only been reduced by a modest amount (Chapter 3) and persistent breaches and drainage congestion make short stemed HYV paddy too risky for a large part of the Project area in the monsoon. As the Project's drainage component has not been fully implemented (Chapter 2) the embankment seems to have aggravated the situation, as heavy rainfall does not have channels and outlets to flow into the rivers, even if the river levels are lower than the water level within the embankment. The result is that the expected yield rate (3.10 mt./ha.), and therefore the annual incremental paddy output, could not yet be achieved in full. The area remains a rice deficit area as before, although the severity might have changed a little due to higher yields from monsoon crops (as a result of reduced flood losses due to the embankment), and expansion of HYV Boro cultivation (due to expansion of private irrigation facilities) but Chapters 9 and 10 suggest little gain in food security.

The findings may be summarised as follows:

i. Change in cultivated area:

- +11 per cent in **Aus**, compared with the control; but (-) 32 per cent compared with pre-project situation;

- No effective change in **Aman**, compared with the control, but +10 per cent compared with pre-project situation;

- +3 per cent in **Boro/Rabi**; compared with the control, but +45 per cent compared with the pre-project situation, (this Boro benefit is related largely with autonomous expansion of minor irrigation, and not with the Embankment as such);

ii. Change in cropping pattern:

- Negligible change in T HYV Aus and T HYV Aman, compared either with the control or the pre-project situation;

- Small shift from Boro LV to Boro HYV compared with the control; significant shift to Boro HYV from B. Aus LV and Boro LV, compared with the pre-project situation (but not due to the Project);

iii. Change in cropping intensity:

- +ve; 174 per cent to 190 per cent (annual), compared with the control;

- +ve; 165 percent to 190 percent (annual), compared with the pre-project intensity;

iv. Change in Paddy Yield:

- +ve; 2.19 to 2.78 mt./ha. (all paddy), Project compared with control area (+27 per cent);

- +ve; 1.55 to 2.78 mt./ha., 1990-91 compared with the pre-project yield (+79 per cent);

v. Change in Paddy Output (incremental output):

+53241mt. (annual), ie. +35 per cent, compared with the pre-project situation; but only 20 per cent of the target;

vi. Change in input use (for paddy only):

+10 per cent chemical fertilizer;
+14 per cent animal labour;
+36 per cent pesticides;
+30 per cent in irrigation costs;
+11 per cent overall input costs;

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vii. Change in value of output:

+34 per cent in paddy;
+33 per cent in all non-paddy crops.

5.4.2 Recommendations

1. There is potential to intensify and diversify cropping patterns. In the monsoon changes toward higher yielding paddy would depend on improved maintenance of the existing Project infrastructure, and reassessment and modification of the drainage system.

2. For drainage improvements a planned programme of khal excavation could help, and might improve surface water availability in the dry season if appropriate control structures are provided.

3. The implementation of the irrigation component of the Project must be re-thought. Private minor irrigation has expanded with great success in the area. Boro cultivation has been boosted. These low-cost irrigation facilities may be encouraged further instead of the proposed high-cost pump houses which might bring additional drainage problems because of gravity distribution canals.

6 LIVESTOCK

6.1 INTRODUCTION

Livestock production is an integral component of the farming system in the Project area. Animals are kept primarily as a supporting activity to crop production. Farm households normally keep a small number of livestock as scavenging animals. Important livestock in the project area are cattle, goats, chicken and ducks. A few buffaloes and sheep are kept by some farm households but horses are very rare in the area. According to the Census of Agriculture and Livestock 1983-84 around 52 percent of total households in the district possess bovine, 57 percent of the households have ovine and 76 percent of the households have chicken and ducks.

Cattle are the most important livestock in the area. Bullocks are kept mainly for draught power and cows for milk and calves. During the peak ploughing season cows are also used for draught purposes to overcome draught power shortages. However, small and marginal farmers regularly use cows both for draught and milk purposes.

The Project had no specific objectives related to livestock development. It was expected that the project would have impacts on crop production particularly paddy production through changing cultivable area, cropping pattern and cropping intensity and hence implications for livestock could have been anticipated. Any increase in cropped area and cropping intensity would lead to reduction of fallow land and grazing area for livestock on one hand and increase requirement for draught animals on the other hand. Any change in the availability of feeds would lead to a change in the cost of production of livestock and livestock products. Indirect impacts on livestock may affect the following parameters:

- Livestock owning household and holding size;
- Livestock feed resources;
- Draught power availability and demand;
- Livestock outputs and cost of production; and
- Livestock health and incidence of diseases.

PIE data and RRA results are used to assess the impacts of the Project on livestock.

6.2 DISTRIBUTION OF SAMPLE HOUSEHOLDS

Livestock production data were collected from 252 sample households, in the protected, unprotected and control areas. The sample households were selected by two-stage random sampling methods and the information on livestock were collected in specially designed pre-tested questionnaires.

Out of 252 sampled households 147 households were in the protected area, 21 households in the unprotected area and 84 households in the control area. In total there were 72 non-cultivating (landless) households, 131 marginal and small farm households and 49 medium and large farm households. Numbers of bovine, ovine and poultry holding households and their distribution are shown in Table 6.1.

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Table 6.1 Distribution of PIE Sample Households

	Impacted Area		Control Area	Total Sample
	Protected Area	Unprotected Area		
Landless Household	42	6	24	72
Bovine HH	4	0	2	6
Ovine HH	7	0	6	13
Poultry	21	0	12	33
Marginal+Small HH	85	13	33	131
Bovine HH	61	7	23	91
Ovine HH	47	6	21	74
Poultry HH	72	12	30	114
Medium+Large HH	20	2	27	49
Bovine HH	19	2	27	48
Ovine HH	14	2	20	36
Poultry HH	19	2	27	48
All Type of HH	147	21	84	252

Source : PIE Household Survey

6.3 IMPACT ON LIVESTOCK HOLDINGS

6.3.1 Change in Number of Livestock Owning Households

The PIE Household survey data on livestock owning households were analyzed and the results are presented in Table 6.2. The results confirm the findings of the RRA that cattle are the most important animals for the farm households in the area. About 56-60 percent of the total households possessed cattle; but only 2-5 percent of the total households, mainly medium and large farm households, kept buffaloes. There was a little variation in the proportion of bovine owning households between the protected and control areas. However, variation in the results was much greater in the unprotected area and was mainly due to the small size of the sample. Therefore, the results of the unprotected area are not considered in interpreting the findings or drawing conclusions.

Table 6.2 Distribution of Livestock Owning Household (in percent)

Species	Impacted Area		Control Area
	Protected Area	Unprotected Area	
Bovine	57	43	62
Cattle	56	43	61
Buffaloes	2	0	5
Ovine (Goats+Sheep)	46	38	56
Poultry	76	67	82
Chicken	76	67	80
Ducks	43	48	51

Source : PIE Household Survey.

The results show that the proportion of bovine owning households increases with increasing operated landholding of the household (Table 6.3). Only 8-10 percent of the landless households and 70-72 percent of the marginal and small farm households had bovine animals. Around 95-100 percent of the medium and large farm households possessed bovine animals. The increased number of bovine owning households with increasing land holding may be due to higher demand for draught animals for land preparation. Moreover, medium and large farm households may have more feed resources, and financial ability for procurement and maintenance of a larger number of livestock, particularly bovine animals. There is no difference in ownership patterns between Project and control areas.

Table 6.3 Distribution of Bovine Owning Household Based on Farm Size (in percent)

Farm size	Impacted Area		Control Area
	Protected Area	Unprotected Area	
Landless Household	10	0	8
Marginal + Small Farm Household[1]	72	54	70
Medium + Large Farm Household[2]	95	100	100

Note: [1] Household having operated land between 0.01 and 2.50 acres.
[2] Household having operated land of 2.51 acre and above.

Source : PIE Household Survey.

Goats and sheep are also important in the Project area. About 46-56 percent of the total households possessed ovines, particularly goats in small numbers as scavenging animals (Table 6.2). The results show that the number of ovine owning households increases with increasing operated land holding (Table 6.4). The results indicate further that the proportion of ovine owning households was slightly smaller in the protected area than the control area. The difference is not significant and indicates at most a minor impact. The RRA results indicated an increase in sheep and goat population between pre-project and post-project conditions. This confirms the findings of the Bangladesh Census of Agriculture and Livestock, 1983-84, that goat population has increased by 2-4 percent per year.

Table 6.4 Distribution of Ovine (Goats + Sheep) Owning Household Based on Farm Size (in percent)

Farm size	Impacted Area		Control Area
	Protected Area	Unprotected Area	
Landless Household	17	0	25
Marginal + Small Farm Household[1]	55	46	64
Medium + Large Farm Household[2]	70	100	74

Note: [1] Household having operated land between 0.01 and 2.50 acres.
[2] Household having operated land of 2.51 acre and above.

Source : PIE Household Survey .

Poultry birds are important in the Project area. About 76-82 percent of all households possessed poultry birds, and chickens are the predominant species of poultry. Only 43-51 percent of households had ducks. The PIE results show that the proportion of poultry owning households increased with increasing operated land holding of the household (Table 6.5). Only 50 percent of the landless households and 85-90 percent of the marginal and small farm households possessed poultry birds. Around 95-100 percent of the M+L farm households had poultry birds. The PIE results indicate that the proportion of poultry owning households is slightly smaller in the protected area than in the control area, suggesting at most a minor Project impact on poultry holding.

6.3.2 Change in the Size of Livestock Holding

The results of the Household Survey and the RRA findings indicate that the size of livestock holding per household is quite small. The PIE results confirm the findings of the RRA that among the livestock, bovines, particularly cattle, are the most important animal to the farm household because of draught power supply. Land preparation and thereby crop production are dependent on animal draught power. The average size of bovine holdings is quite small, 1.8 head/household in the protected area and 2.4 head/household in the control area (Table 6.6). In other words, the average bovine holding in the protected area is 25 percent lower than in the control area.

Table 6.5 Percentage of Poultry Owning Household by Farm Size

Farm size	Impacted Area		Control Area
	Protected Area	Unprotected Area	
Landless Household	50	0	50
Marginal + Small Farm Household[1]	85	92	91
Medium + Large Farm Household[2]	95	100	100

Note: [1] Household having operated land between 0.01 and 2.50 acres.
[2] Household having operated land of 2.51 acre and above.

Source : PIE Household Survey.

Table 6.6 Mean Number of Livestock per Household

Species	Impacted Area		Control Area
	Protected Area	Unprotected Area	
Bovine	1.8	1.1	2.4
Cattle	1.7	1.1	2.3
Buffaloes	0.3	0	0.1
Ovine (Goats+Sheep)	1.1	1.0	1.3
Poultry	8.2	7.2	10.5
Chicken	6.3	4.7	7.3
Ducks	1.9	2.6	3.3

Source : PIE Household Survey.

The average size of bovine holding per owning household in the protected and control areas is shown in Table 6.7. The results indicate that an average owning household possessed 3.1 head of cattle in the protected area and 3.8 head in the control area. The RRA results indicate that the bovine population has slightly increased in the Project area as compared to the pre-project condition. Since the size of bovine holding per household in the protected and control areas during pre-project conditions is not available, it is difficult to conclude that the smaller size of bovine holding in the protected area is due to the Project. Further study would be required to ascertain the long term impact of the Project on bovine holdings.

Table 6.7 Mean Number of Livestock per Owning Household in the Protected and Control Areas

Species	Impacted Area		Control Area
	Protected Area	Unprotected Area	
Bovine	3.1	2.7	3.9
Cattle	3.1	2.7	3.8
Buffaloes	1.7	0	2.2
Ovine (Goats+Sheep)	3.4	2.6	2.4
Poultry	10.8	10.9	12.8
Chicken	8.3	7.0	9.1
Ducks	4.5	5.4	6.4

Source : PIE Household Survey.

The PIE results show that the size of bovine holdings increases with increasing land holding of the household both in the protected and control areas (Table 6.8). Table 6.8 shows that big farmers keep more cattle for cultivation of their land. Moreover, medium and large farmers have more financial ability and feed resources for procurement and maintenance of a larger number of cattle head than the average farmer. There is no systematic Project related difference.

Table 6.8 Number of Bovine per Household Based on Farm Size

Farm size	Impacted Area		Control Area
	Protected Area	Unprotected Area	
Mean for All Households			
Landless Household	0.1	0	0.1
Marginal + Small Farm Household[1]	2.0	1.1	1.7
Medium + Large Farm Household[2]	4.5	5.0	5.4
Mean for Owning Households			
Landless Household	1.3	0	1.0
Marginal + Small Farm Household[1]	2.8	2.0	2.4
Medium + Large Farm Household[2]	4.7	5.0	5.4

Note: [1] Household having operated land between 0.01 and 2.50 acres.
[2] Household having operated land of 2.51 acre and above.

Source : PIE Household Survey.

The average size of ovine holdings was slightly lower in the protected area than in the control area (Table 6.6). However, each owning household possessed 3.4 heads of ovine animal in the protected area and 2.4 heads in the control area. The PIE results indicate that the size of ovine holding per household increases with increasing land holding of the farm household (Table 6.9). This may be explained by the fact that medium and large farm households have more financial ability and feed resources for keeping goats. Moreover, a smaller size of goat holding may not be economically viable in the area.

Table 6.9 Mean Number of Ovine (Sheep + Goats) per Household Based on Farm Size

Farm size	Impacted Area		Control Area
	Protected Area	Unprotected Area	
Mean for All Households			
Landless Household	0.4	0	0.4
Marginal + Small Farm Household[1]	1.3	0.9	1.1
Medium + Large Farm Household[2]	1.9	4.5	2.4
Mean for Owning Households			
Landless Household	2.6	0	1.5
Marginal + Small Farm Household[1]	2.3	2.0	1.8
Medium + Large Farm Household[2]	2.7	4.5	3.3

Note: [1] Household having operated land between 0.01 and 2.50 acres.
[2] Household having operated land of 2.51 acre and above.

Source : PIE Household Survey.

The average household possessed a slightly smaller number (8.2 birds/HH) of birds in the protected area than in the control area (10.5 birds/HH) (Table 6.6). Chicken is the predominant species of poultry in the area. Size of duck holding is quite small, 1.9 ducks per household in the protected area and 3.3 ducks per household in the control area. Table 6.7 shows the size of poultry holding per owning household. The results indicate that the size of poultry holding per owning household is also slightly lower in the protected area than the control area.

The number of poultry per household also increases with increasing land holding of the farm household (Table 6.10) in both Project and control areas.

Table 6.10 Number of Poultry per Household Based on Farm Size

Farm size	Impacted Area		Control Area
	Protected Area	Unprotected Area	
Mean for All Households			
Landless Household	3.7	0	2.7
Marginal + Small Farm Household[1]	8.6	8.3	9.8
Medium + Large Farm Household[2]	16.1	22.0	18.4
Mean for Owning Households			
Landless Household	7.3	0	5.3
Marginal + Small Farm Household[1]	10.2	9.0	10.8
Medium + Large Farm Household[2]	16.9	22.0	18.4

Note: [1] Household having operated land between 0.01 and 2.50 acres.
[2] Household having operated land of 2.51 acre and above.

Source : PIE Household Survey.

6.4 IMPACT ON DRAUGHT POWER

6.4.1 Draught Power Requirement

The Project may be expected to have had some impact on draught power requirements in the project area. Protection from floods and improve drainage conditions lead to changes in cropping pattern and cropping intensity. They may also lead to changes in the cropped area in different cropping seasons, which may ultimately cause changes in draught power requirements for land preparation in the project area.

The PIE results indicate that the average operated area per farm household was lower in the protected area (0.50 ha, 1.24 acre/HH) than in the control area (0.83 ha, 2.07 acre/HH). Households in the unprotected area had the least quantity of operated land (0.39 ha, 0.96 acre/HH). The cropped area per household was the highest in the Aman season and the lowest in Aus season (Table 6.11). Although there are big differences in the cropped area between the protected and control areas, the results show that about 81 percent of total operated land per household remained under cultivation in the Aman season both in the protected and control areas. In the Aus season, on the contrary, about 56 percent of the land per household was in cultivation in the protected area and 45 percent of land in the control area. The cropping intensity was also higher (190 percent) in the protected area than the control area (175 percent). Since the actual operated area per household was higher in the control area, the draught power requirement would also be higher in that area.

Table 6.11 Operated and Cropped Areas per Household in Different Cropping Season (in acre)

Operated land/HH (acre)	Impacted Area		Control Area
	Protected Area	Unprotected Area	
Total operated area	1.24	0.96	2.07
Cropped Area in:			
- Aus Season	0.70	0.35	0.93
- Aman Season	1.01	0.72	1.69
- Boro Season	0.65	0.67	1.00
- All season	2.36	1.74	3.62

Source : PIE Household Survey.

6.4.2 Change in Draught Animal Availability

Supply of draught power for land preparation is the most important contribution of livestock in the Project area. As already shown in Sections 6.3.1 and 6.3.2 the number of bovine owning households and the size of bovine holdings per household vary with the farm size and between protected and control areas. Bullocks are the most important draught animals. Buffaloes and bulls are also used for draught power whenever available but cows are used when there is a shortage of draught animals.

Table 6.12 shows the average composition of bovine holdings in the protected and control areas. Although the total number of bovine animals, as well as the number of bullocks and bulls per household, is higher in the control area than in the Project, the proportion of bullocks and bulls to total bovine animals in both the areas is very close (42 percent in the protected area and 45 percent in the control area). The overall composition of bovine holding per household is similar in both the protected and control areas.

Table 6.12 Composition of Bovine Holding in the Protected and Control Areas

No. of animal/HH	Impacted Area		Control Area
	Protected Area	Unprotected Area	
Bullock+Bull/HH	0.76	0.57	1.10
Cows/HH	0.61	0.38	0.75
Calves/HH	0.40	0.19	0.48
Buffaloes/HH	0.03	0	0.11
Total Bovine/HH	1.80	1.14	2.44

Note: HH = household

Source : PIE Household Survey.

Since the draught power ability of different bovine animals varies, for effective comparison it is necessary to convert all bovine animals into draught animal units (DAU) by using the following conversion factor.

DAU = 1.0 x (Bullocks + Bulls) + 0.5 x Cows + 2.0 x Buffaloes

The available DAU per household in the protected and control areas is shown in Table 6.13. The number of DAU per household was smaller in the protected area than in the control area. But in the unprotected area there was the smallest number of DAU per household. The results show that about 67 percent of DAU came from bullocks and bulls, 27 percent from cows and 5 percent from buffaloes in the protected area. However, there was a small variation in the composition of DAU between the protected and control areas. Although the size of bovine holdings and DAU holdings per household was bigger in the control area than in the protected area, the DAU per acre of operated land was bigger in the protected area than in the control area. That means the average farm household in the protected area will be in a better position regarding availability of draught animals for land preparation.

Table 6.13 Availability of Draught Animal Unit (DAU) per Household (HH) in the Protected and Control Areas

Draught animal/HH	Impacted Area		Control Area
	Protected Area	Unprotected Area	
Bullocks+Bulls/HH	0.76	0.57	1.10
Cows/HH	0.61	0.38	0.75
Buffaloes/HH	0.03	0	0.11
DAU/HH	1.13	0.76	1.68
DAU/Acre operated land	0.91	0.79	0.81

Note : HH = Household

Source : PIE Household Survey.

6.4.3 Demand and Supply of Draught Power

Requirements for draught power vary with the operated landholding per household and with the cropped area in different cropping seasons. Draught power supply depends on the size of the livestock holding per household. As already shown in Table 6.11 the operated land per household varied with the cropping season and with the farm size. The area of operated land per household was the highest in the Aman season. In the protected area, the proportion of cropped land to the total operated land was 81 percent in Aman season, 56 percent in Aus season and 52 percent in Boro season; but in the control area the proportion of cropped area was 82 percent in Aman season, 45 percent in Aus season and 48 percent in Boro season. In general a pair of DAU requires around 15 days for cultivation of one acre (0.40 ha) of land. So 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, about 45-60 days.

But in Aus and Aman seasons, when land preparation and sowing/ planting are dependent on natural rainfall, the time available for land preparation is very short, usually 25-30 days. As such when more land has to be cultivated in a shorter period of time, the supply of draught power for land preparation will be critical.

Table 6.14 shows the size of the operated land per pair of DAU in the critical Aman season for medium and large farm households. The results indicate that there was a higher acreage of operated land per pair of DAU for the medium and large farm households than for the average household. In the Aman season, which is a critical season for draught power requirements, the operated land per pair of DAU was less than two acres, except for medium and large farm households, who have more than two acres both in the protected and control areas. This indicates that there is no overall shortage of DAU both in the protected and control areas. However, in the Aman season particularly for medium and large farm households, there is a shortage of DAU per household both in the protected and the control areas.

Table 6.14 Requirement and Supply of Draught Power in Aman Season and for M+L Farm Household

Land/Pair DAU (in acre)	Impacted Area		Control Area
	Protected Area	Unprotected Area	
DAU/HH (in No.)	1.13	0.76	1.68
Operated land/Pair DAU	2.21	2.51	2.46
Operated land/Pair DAU for M+L Farm HH	2.57	3.86	2.56
Cropped land/Pair DAU in Aman Season	1.82	1.88	2.01
Cropped land/Pair DAU in Aman Season for M+L Farm HH	2.20	3.17	2.15

Source : PIE Household Survey.

Time requirements for cultivation of operated land by different categories of household with their available DAU in different cropping seasons are shown in Table 6.15. In this calculation an assumption is made that a pair of DAU requires 15 days for cultivation of one acre (0.40 ha) of operated land. The results indicate that there is no significant shortage of draught power to cultivate operated land in different cropping seasons except, particularly in Aman season, for medium and large farm households.

From the above discussion it could be concluded that there is apparently no great shortage of draught animals in the area. The Project has had little impact in changing draught animal requirements in the area. The draught power requirement was higher in the Aman season than the other seasons. There was a shortage of DAU particularly for medium and large farm households in the Aman season. In general about 67 percent of total DAU comes from bullocks and bulls, 27 percent from cows and 5 percent from buffaloes in the Project area.

Table 6.15 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	17	24	15	16	21	16	14	25	21
Medium + Large	23	33	22	8	48	53	18	32	17
All Types	19	27	17	14	28	26	17	30	18

Source : PIE Household Survey.

6.5 IMPACT ON LIVESTOCK FEEDS

It may be expected that the Project would have some impact on livestock feed resources particularly on availability of fallow land and grazing area and thereby on availability of green feedstuff. Increased production of paddy in the Project area would lead to concomitant increase in paddy straw and rice bran for bovine animals. The RRA results indicate a reduction of grazing area and green feedstuff in the Project area. It gives further indication that the straw production in the area has increased due to increased production of paddy. However, the palatability and digestibility of the straw have declined due to the cultivation of HYV paddy rather than LV paddy.

Table 6.16 shows that about 61 percent of the total households or 100 percent of bovine owning households fed green feedstuff to their bovine animals. A similar number of households also fed dry roughage, mainly paddy straw, and concentrate feeds, mainly rice bran and oil cake, to their cattle. However, there is very little difference in the number of households feeding green, dry and concentrate feeds between the protected and control areas.

Table 6.16 Percentage of Households Feeding Green and Dry Feeds to Bovine Animals in Last 12 months (1990-91)

Areas	Type of Feeds Bought		
	Green feedstuff (% HH)	Dry feedstuff (% HH)	Concentrate feed (% HH)
Protected	61	57	59
Unprotected	43	43	38
Control	62	62	62

Source : PIE Household Survey.

The amounts spent for feeding bovine animals are shown in Table 6.17. The results indicate that the highest amount of money was spent for dry roughage and the smallest amount for green feedstuff both in the protected and control areas. The amount spent for feeding bovine animals was higher in the control area than in the protected area for all three categories of feed. The higher spending per household in the control area may be related to the number of cattle per household. Lower expenditure on green feedstuffs might be due to insufficient availability of green feeds in the area. However, it is likely that green feed availability has declined since the Project is both Project and control areas, and is not a project impact.

Table 6.17 Amount Spent per Household for Feeding their Animals in Last 12 Months (1990-91)

Areas	Type of Feeds Fed					
	Green Feed		Dry Feed		Concentrate Feed	
	Amount/HH (Tk)	Amount/ Owning HH (Tk)	Amount/HH (Tk)	Amount/ Owning HH (Tk)	Amount/HH (Tk)	Amount/ Owning HH (Tk)
Protected	288	476	610	1068	293	501
Unprotected	240	561	367	856	129	388
Control	347	540	788	1226	420	619

Source : PIE Household Survey.

6.6 IMPACT ON LIVESTOCK HEALTH

The Project may have had some impacts on livestock health and incidence of diseases. The RRA results indicate that there is a general deterioration of cattle health in the area mainly due to shortage of nutritious feeds, extreme seasonal fluctuation of feed supply, and seasonal overwork of the animals.

The Household survey results on the use of veterinary facilities are presented in Table 6.18. Very similar percentages of households used veterinary services in both areas implying neither increased health problems nor increased investment in preventive treatment in the Project. In addition, the amount spent per household for treatment and vaccination of animals is quite small.

Table 6.18 Incidence of Veterinary Treatment and Amount Spent

	Impacted Area		Control Area
	Protected	Unprotected	
% HH used Vet. Treatment	34	24	31
Amount Spent/HH for Treatment (Tk)	22	6	35
Amount Spent/spending HH for Treatment (Tk)	65	25	113

Source : PIE Household Survey.

6.7 HOUSEHOLD INCOME FROM LIVESTOCK

Household income from livestock consists of sales of live animals, sales of livestock products (milk, meat, eggs, skins and cowdung) and sale of draught power, namely ploughing (Hal) and bullock cart. In calculating household income from livestock the value of Hal used in one's own field and the value of bullock cart used for transportation of own goods have not been included. Data on household incomes from livestock sources are presented in Table 6.19. The average sales of live animals were slightly higher in the protected area than in the control area. Bovines contribute the lion's share of the sales of live animals both in the protected and control areas. Sales of livestock products were slightly lower (Tk. 747/HH) in the protected area than the control area (Tk. 848/HH). Milk contributes about 49 percent of sale value in the protected area and 33 percent in the control area.

Table 6.19 Average Household Income from Sale Proceeds of Live Animals and Livestock Products (in Tk) in 1990-91.

Sources	Impacted Area		Control Area
	Protected Area	Unprotected Area	
Sale Proceeds from Live Animals	895	590	830
Bovine/HH	648	462	531
Ovine/HH	70	0	96
Poultry/HH	177	128	203
Sale Proceeds from Livestock Products	747	522	848
Milk/HH	367	290	280
Meat/HH	27	0	118
Eggs/HH	146	139	175
Others/HH	207	93	275
Total/HH	1642	1112	1678

Source : PIE Household Survey

The net incomes per household from livestock sources, are shown in Table 6.20. Although the gross income per household from livestock sources was slightly lower in the protected area, the net income was significantly higher than the control area. The cost of production and return from livestock indicate that livestock production in its present form may not be very economic in the area.

Table 6.20 Net Income/Household from Livestock Sources in 1990-91

Item	Impacted Area		Control Area
	Protected Area	Unprotected Area	
Gross Household Income from Livestock	1642	1112	1678
Cost of Feeds and Treatment/HH	1213	742	1590
Net Income/HH	429	370	88

Source : PIE Household Survey.

6.8 SUMMARY

A careful assessment of the data on livestock production between the protected and control areas indicates that there may be a negative impact of the Project on livestock. In the protected area the proportion of households owning bovine animals was lower, average holding size was lower and as a result the availability of draught power per household was substantially lower in the protected area. Nevertheless, there was no overall shortage of draught animal units (DAU) in the protected and control areas. However, there is a slight shortage of DAU in Aman season for the medium and large farm households both in the protected and the control areas.

It is not clear if the relative availability of green and by product feeds charged because of the Project, but on average less was spent on purchased feeds in the Project area.

The proportion of households owning goats and sheep, and size of ovine holding per household was lower in the protected area than the control area. The proportion of chicken and duck owning households, as well as their holding size per household, was also lower in the protected area than the control area.

Average income from sale of live animals was higher in the protected area than the control area, but income from livestock products was lower in the protected area. Net income per household from livestock sources was substantially higher in the protected area.

6.9 RECOMMENDATIONS

A number of measures are possible to improve livestock production, and these may be particularly useful if feed availability has declined:

- high yielding forage crops such as napier and para grass could be cultivated on the slopes of the embankment and around homesteads, which will not only produce green feedstuff during crisis periods but also reduce soil erosion of the embankment. Para grass may be cultivated on the lower part of the embankment slopes and by the borrow pits because it grows better on wet land;

- some cultivated fallow land may be used for food and forage crops (maize, sorghum, khesari, cowpea) cultivation in order to minimize feed shortage;

- pulse and oilseed cultivation may be encouraged through introduction of a crop diversification programme which will help in improving the nutritional status of the people, providing nutritious cattle feed and increasing soil fertility;

- during selection of HYV paddy some consideration may be given to straw quality because straw of some HYVs has higher digestibility. This will help to improve straw quality along with the increase in rice production;

- paddy straw is the main feedstuff of cattle, and is low in digestibility and nutrient content. Urea treatment of straw improves both N-content and digestibility of straw, so an extension programme may be undertaken to popularize urea treatment of straw for improving cattle nutrition in the Project area;

- a programme for introduction of urea-molasses blocks for feeding cattle with the straw ration could be undertaken. Urea-molasses blocks are a good source of energy and nitrogen for rumen micro-organisms (which digest feeds). Moreover, rumen micro-organisms are a good source of protein for the ruminant. Feeding urea-molasses blocks as supplementary feed for cattle on straw based rations will not only improve digestibility and palatability of straw but also improve total nutrient intake of the animal; and

- the extension programme of the Department of Livestock Services should be extended and strengthened in the area. Provision should be made to provide routine vaccination and mass anthelmintic (worming) doses in the area to protect animals against prevalent infectious and parasitic diseases.

7 FISHERIES

7.1 CAPTURE FISHERIES

7.1.1 Background

In the Project planning (Techno Consult, 1971), the Project impacts on fisheries were totally overlooked. There was no base line information regarding the size and distribution of fishermen communities, number and area of different types of water bodies, annual catches and number of traders involved in fish trading within the Project area. All these data are necessary to reliably assess the impacts of the Project on fisheries. However, a total of 1500 fishermen in the Project area and 1000 in the control area have been estimated in the present study. Out of these, 21 fishermen were interviewed in the Project area and 15 in the control area to assess the impacts of the Project on capture fisheries.

7.1.2 Catch Rates

The average daily catch and the average number of fishing days per year per fisherman were determined from PIE responses and are presented in Tables 7.1 and 7.2.

Table 7.1 Average Capture Fish Catch per Fishermen per Day (kg.)

Items	Impacted Area	Control Area
Now	2.3	2.2
Before	4.7	3.0

Source: FAP - 12 PIE Survey

Table 7.2 Average Number of Fishing Days per Fishermen per Year

Items	Peak Period	Lean Period	Total
Impacted Area			
Now	113	130	243
Before	120	144	264
Control Area			
Now	102	155	257
Before	100	155	255

Source: FAP - 12 PIE Survey

Table 7.1 shows a great impact of the Project on the catch of the fishermen in both the areas. The decline in average catch per day per fisherman is much higher in the impacted area (104 per cent) than in the control area (36 per cent). These findings are in conformity with findings of the RRA study which reported a sharp decline in fish catch due to blockage of fish migration routes by the embankment and sluices and drying up of some waterbodies by siltation. However, the average number of fishing days shows only a slight difference from the pre-project period in the Project area, and a negligible difference in the control area (Table 7.2). The current average catch per day is the same both in impacted and control areas, but the rates differ significantly from the pre-project period. The number of fishermen selected for interview was too small compared with the total number of fishermen, for a reliable assessment to be made of the actual impacts of the Project on capture fisheries. For this purpose further studies with relatively large samples should be carried out in future project evaluation studies to achieve a comprehensive assessment of fisheries resources.

As in other projects the peak and lean fishing periods recorded in the PIE study were found to be governed by the time and duration of flooding. No difference in duration of fishing periods was recorded in the impacted area between the present and pre-project situations. However, both peak and lean fishing periods in the impacted area differed from the control area. In general the peak period extends from June to January in the impacted area and July to December in the control area. The lean period in each area covers the remaining months. Hence the fishing period is prolonged in the project area probably reflecting its proximity to the major rivers.

7.1.3 Catch Composition

Fishermen's responses regarding their catches, by average quantity and value, and by main fish groups are shown in Table 7.3.

Table 7.3 Average Catch per Fisherman During 1990/91

Species	Impacted area			Control area		
	Quantity (kg.)	%	Value (Tk.)	Quantity (kg.)	%	Value (Tk.)
Major carps	56	10	2813	15	3	734
Catfish	25	4	844	19	3	652
Snake-heads	3	1	100	2	0	107
Hilsa	46	8	1146	30	5	853
Tilapia	10	2	264	2	0	40
Minor carps	85	14	2858	87	16	3087
Live fish	-	0	7	2	0	53
Shrimp	117	20	2292	70	13	850
Other species	214	36	3210	326	59	4935
Total capture fish	556	(94)	13534	553	(100)	11311
Pond fish (mainly carps)	33	6	1048	-	0	-
Overall Total	589	100	14582	553	100	11311

Source: FAP - 12 PIE Survey

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Fishermen were unable to provide reliable information about their pre-project catches and values (pre 1983), hence only the present catch quanties and values of different species have been recorded from the responses of fishermen. The variations in quantities and values of different species between impacted and control areas might be associated with the variations in the types of water bodies, fishing by fishermen and the variations in prices of fishes with location. The contribution of wild caught large species appears to be higher in the Impacted area, explaining the difference in averaging catch value per fishermen. The breaches in the embankment and proximity to the rivers of the impacted area may explain the differences.

Table 7.4 Comparison of 1990/91 and Pre-project Catches
(No. of fishermen responding)

Extent of change	Impacted	Control
Increased more than 25%	-	-
Increased up to 25%	2	-
Catch about the same	2	2
Decreased up to 25%	1	3
Decreased more than 25%	14	10
Total no. of respondents	21	15

Source: FAP - 12 PIE Survey

Fishermen were asked to compare present catches with pre-project catches. Like Chalan Beel Polder D, this project also shows some positive effects where 10 per cent of fishermen claimed an increase of up to 25 per cent in fish production which is analogous to a large average catch of major carps in the impacted area (Table 7.4). This might be because flood control in the impacted area has provided some opportunities for development of culture fisheries, as reported by fishermen and traders. The successful fisheries extension effort, implementation of New Fisheries Management Policy, and NGO activities in some water bodies within the Project area are also contributing factors for increased culture fish production (see Section 7.2). However, the Project has greatly reduced the capture fisheries in both the areas. About 67 per cent fishermen claimed losses of capture fish production of more than 25 per cent (Table 7.4). Accordingly the commercially important fish species have also declined greatly after the Project. Major carp, catfish and livefish were found to have decreased more than the other species (Table 7.5). These findings also agree with those of the RRA study where it has been reported that the availability of fish declined sharply after the Project.

Table 7.5 **Changes in Species Composition of the Catch**
(No. of fishermen responding)

Species	Area	Increased		No change	Decreased	
		25% plus	Up to 25%		Up to 25%	25% plus
Major carps	Impacted	4	1	-	1	11
	Control	-	-	-	-	10
Catfish	Impacted	-	-	-	1	8
	Control	-	-	-	2	5
Hilsa	Impacted	-	-	-	-	-
	Control	-	-	-	1	-
Life fish	Impacted	-	-	-	-	7
	Control	-	-	-	-	5
Minor carp	Impacted	-	-	-	-	2
	Control	-	-	-	-	-
Snake head	Impacted	-	-	-	-	-
	Control	-	-	-	-	-
Shrimp	Impacted	-	-	-	-	-
	Control	-	-	-	-	-
Other Species	Impacted	-	-	1	-	10
	Control	-	-	-	2	8

Source: FAP - 12 PIE Survey

7.1.4 Reasons for Change

The causes of the decline in fish stock and catches, as stated by the fishermen from the Project and control areas during PIE survey, are listed in Table 7.6.

Project related causes reported are relatively unimportant: blockage of migratory routes by the embankment and drying of water bodies (10 per cent) and are as important in the control area as the Project area. The only cause of increased fish production noted was an expansion of pond fish culture. However, among the non-project related factors, the fish disease, use of current nets and excessive capture of immature fish are reported to be more important factors by the fishermen from both the areas (Table 7.6). The RRA data placed greater emphasis on the blocking of khal mouths at the river side, either by the embankment or sluice gates which hamper fish migration from the main rivers to the Project area and vice versa. It has also been reported that blocking of outfalls stopped water flow, resulting in accelerated siltation within the Project and thereby reducing the fish stock by drying up and reducing the area of many perennial and seasonal water bodies. However, the fishermen placed less emphasis on such processes and hence the Project impact may not have been so severe.

Table 7.6 Fishermen's Views on Causes of Project Impact
(Number of fishermen responding)

Cause of Impact	Impacted area	Control area
Fish access blocked by embankment	3	2
Excess use of fertilizer and pesticides	-	2
Use of current nets	5	7
Fish disease	17	9
Excessive capture of immature fish	3	6
Drying of water bodies	2	8
More pond culture	1	2
Less fish	-	1
God's will	7	5
Total respondents	21	15

Source: FAP - 12 PIE Survey

7.1.5 Fishermen's Employment and Incomes

Mean incomes and expenditure from fishing are given in Table 7.7.

Table 7.7 Fishermen's Income and Expenditure, 1990/91 (Tk.)

Items	Impacted area	Control area
Average catch (kg.) from Table 7.3	589.0	553.0
Fish kept for home consumption (kg.)	45.0	35.0
Quantity sold (kg.)	544.0	518.0
Mean value (weighted average) Tk./kg.	24.7	20.4
Gross income (Tk.)	13437.0	10567.0
Boat costs-upkeep and depreciation (Tk.)	709.0	199.0
Fishing gear repairs and replacements (Tk.)	1105.0	1198.0
Licences, leases, other costs (Tk.)	510.0	769.0
Total costs (Tk.)	2324.0	2166.0
Net income (Tk.)	11113.0	8401.0

Source: FAP - 12 PIE Survey

Table 7.7 indicates that Project fishermen have higher gross incomes and costs than those in the control area and as a result net income per fishermen is 32 per cent more than in the control area. The high expenditure on boats, and higher value (per kg.) of their catch, suggests that impacted area fishermen are more active in the main rivers (which are distant from the control area), and hence this may not be a Project related difference.

The expansion of culture fisheries in the impacted area might have contributed to this difference.Some of the fishermen are paid a small fee in cash or kind or both for catching from ponds, whilst others buy the fish from the pond owner and take them to market for sale at a higher price. For more detailed and relatively more reliable information large samples of fishermen are needed in future project evalution and monitoring.

Table 7.8 Breakdown of Family Members Effort in Fisheries Work
(Percentage of involvement in total fisheries related work by the family members)

Items	Impacted area	Control area
Men		
Fish catching	25	15
Boat and gear repairing	37	38
Fish processing	1	1
Fish trading	19	16
Wives and Children		
Fish catching	-	-
Boat and gear repairing	17	30
Fish processing	1	-
Fish trading	-	-
Total percentage	100	100

Source: FAP - 12 PIE Survey

Table 7.8 shows little difference between the two areas in the breakdown of family members by different types of work related to fisheries. However, women and children contribute more time to the household fishing effort in the control area, where less effort seems to be made in fish catching. It is interesting to note that most of the family members get involved in boat, gear and equipment repairing. Although the fishermen are involved in fishing and trading to a great extent, the remaining family members hardly take part in these activities. As in other PIE areas the involvement in fish processing is negligible which indicates the sale of fish mostly in fresh condition.

7.2 FISH FARMING

7.2.1 Details of Ponds

There was a lack of background and up to date information on culture fisheries. The project documents and relevant organizations could not provide information on the pre-project situation (specially the number, area, cultural status and distribution of fish ponds in the Project area). Table 7.9 gives details of the fish ponds surveyed during the PIE.

Table 7.9 Numbers of Ponds and Ownership Status

Items	Impacted area	Control area
No. of pond-owners interviewed	17	3
No. of ponds involved	18	3
Area of ponds owned (ha.)	2.80	2.35
Average pond size (ha.)	0.10	0.1*
Single owner ponds (no.)	6	2
Jointly owned ponds (no.)	11	1
Estimated total pond area (ha.)	492.00	120.00

Source: FAP - 12 PIE Survey
Note: *Average pond size excludes one exceptionally larger pond.

Very few pond owners were interviewed in the control area compared to the impacted area (Table 7.9). This is because only the pond owners stocking fish were interviewed in the PIE survey. The number of pond owners cultivating fish appears to be greater in the impacted area because of better protection from annual flooding by the embankment. However, the Project could not ensure this benefit to pond owners in some parts of the Project due to rain water flooding caused by inadequate drainage facilities and frequent breaches in the embankment. The average pond size (0.1 ha) in both the areas is almost the same as the national average, which ranges between 0.1 to 0.2 ha., with the exception of one big pond (2.2 ha.) in the control area. This pond was excavated in formerly water-logged ground with technical guidance from the Upazila Fishery Officer (UFO) and additional assistance from an NGO. It is now 3 years old and producing about 1190 Kg./ha./year.

The reasons for excavation of ponds and their utilization so far reported by pond owners are presented in Table 7.10.

As is already widely known (see other FAP 12 PIE studies) ponds were excavated mostly for making homestead mounds and to serve as a water source for household use. However, according to Table 7.10 about 52 per cent of new ponds were constructed for fish culture and 24 percent excavated for house construction in the impacted area as compared to 100 per cent pond construction for fish culture in the control area. This may be associated with increased awareness of farmers about the benefits of pond fish culture. Despite this no farmer is found to use the pond only for fish culture, most of them use ponds for several purposes. About 88 per cent of pond owners in the impacted area and 67 per cent in the control area use ponds both for fish culture and household purposes. These multiple uses of ponds may create a bottle-neck in introducing more intensive fish culture as they cause deterioration of water quality. The pattern of pond use is almost the same in both areas.

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Table 7.10 **Reasons for Pond Excavation and Use**
(No. of pond owner responding)

Items	Impacted area	Control area
Ponds excavated		
- for fish culture	9	3
- for house construction	4	-
- for other purpose	1	-
Pond utilization		
- for fish culture only	-	-
- also for household use	15	2
- also for livestock	5	2
- also for irrigation	2	-
Total no. of respondents	17	3

Source: FAP - 12 PIE Survey

The vulnerability of ponds to being over-flooded has been a major constraint to fish farming development. Table 7.11 shows that out of 17 ponds 6 were flooded before the Project. The Project now protects about 50 per cent of them from annual flooding. The Project should have protected all the ponds from annual flooding, but it could not do so because of the excessive rain water congestion caused by inadequate drainage provision and frequent embankment breaches. Therefore, the potential for increased pond fish production is limited by the partial nature of flood protection and drainage.

Table 7.11 Pond Owners Assessment of Flooding Risks
(Nos. of respondents)

Risk	Impacted area	Control area
Ponds subject to flooding before	6	-
Ponds still subject to flooding	3	-
Total respondents	17	3

Source: FAP - 12 PIE Survey

7.2.2 Pond Fish Productivity

Table 7.12 shows a considerable difference in average pond fish production between impacted and control areas. The average production in the control area (1238/ha.) is slightly less than the national average (1400 kg./ha.) whereas in the impacted area it is 42 per cent more than the national average. This clearly indicates greater adoption of improved fish culture methods in the impacted area. The relatively greater extension activities of the Upazila Fisheries Officer and NGOs, and their technical guidance and other assistance, may explain this increase in fish production in the impacted area. However, extension activity has improved to a considerable extent, since project implementation in both areas; as reported by about 50 per cent, of respondents in the impacted and 67 per cent in the control areas (Table 7.13). Hence this is not a Project impact. A comparatively large average catch of carp in the impacted area (Table 7.12) supports the statements. Almost all the respondents reported to have used more fertilizers and feed in their fish ponds (FAP 12 Final Report Appendix Table J.19) which are the contributing factors for increased production.

Table 7.12 Average Productivity of Fish Ponds (kg./ha.)

Species	Impacted area	Control area
Carps	1733	1206
Catfish	80	-
Tilapia	13	-
Shrimp	27	16
Other species	133	16
Total	1986	1238

Source: FAP - 12 PIE Survey

Table 7.13 Effectiveness of DOF Aquaculture Extension Work
(Nos. of respondents)

Items	Impacted area	Control area
Extension effort has improved	8	2
Remains about the same	8	1
Extension is worse now	1	-
Total respondents	17	3

Source: FAP - 12 PIE Survey

The statements of the pond owners about the trends in farm fish production in both the areas (Table 7.14) also support the findings of Tables 7.12 and 7.13.

Most of the pond owners in the impacted area claimed an increase in pond fish production after project implementation. The reasons for this improved yield as stated by the pond owners are protection of ponds against annual flooding, increased extension activities, more technical guidance and assistance from UFO and NGOs, higher fish prices, and the availability of good fish seed. This intensive fish cultivation has been possible where flooding was not a risk, and where the Project has been effective in reducing the risk. Only a few pond owners claimed a reduction in pond fish production, but they also stated that this decline is associated with embankment breaches, drainage congestion in certain parts of the Project, and with fish mortality due to disease. In the control area no pond owner claimed a reduction in fish production (Table 7.14) which is consistent with the reported improved extension activities in the control area (Table 7.13).

Table 7.14 Trends in Farmed Fish Production
(Nos. of respondents)

Extent of change	Impacted area	Control area
Increased more than 25%	3	1
Increased up to 25%	6	-
Not changed	2	2
Decreased up to 25%	1	-
Decreased more than 25%	1	-
Total respondents	17	3

Source: FAP - 12 PIE Survey

The profitability of fish ponds apears to be on the increase because of fish supply shortages, price rises and better yields due to adoption of improved technology. The situation in the Project area as compared to the control area is presented in the Table 7.15.

Table 7.15 Average Fish Pond Profitability ('000 Tk./ha.)

Items	Impacted area	Control area
No. of respondents	17	3
Average sales income	72.4	47.6
Average costs for stocking, feeding and harvesting ponds	32.6	15.9
Average net income	39.8	31.7

Source: FAP - 12 PIE Survey

Income and expenditure between the impacted and control areas differ greatly (Table 7.15), consequently the net return in the impacted area is about 26 per cent higher than in the control area ponds. These differences indicate adoption of more intensive fish culture supporting the findings in Tables 7.12 to 7.14. It might be that pond owners in the control area do not invest more money in fish farm inputs as compared to the impacted area due to flood risk. However, the average returns obtained in both the areas are within the national average. If the flood problem can be solved in certain areas of the Project, culture fish production could be increased to a great extent by bringing all the ponds under improved fish culture. This would give substantial benefits to pondowners, but would at least bring more work to fishermen in the Project area.

7.3 FISH MARKETING

Very few fish traders could be selected for PIE interview compared to the total number of traders per market (FAP 12 Final Report Appendix Table J.27). Only 3 traders, one from each of three markets, were interviewed in the Project area, and 3 in the control area. They can hardly be considered as a representative sample of fish traders in both the areas. DOF annual fisheries statistics contain very little information on fish marketing and contain virtually no data on the numbers of fish traders or their activities. Similar to other projects most of the traders carryout their business in several markets during a month, both within and outside the Project. Naturally by virtue of their profession the traders have good linkages with fishermen and other traders, and are therefore likely to have a good knowledge of seasonal changes and long term trends in fish production. Besides the decline in capture fish production has compelled a good number of fishermen to take up fish trading on a part-time basis. (Table 7.8 supports this statement). An exceptional increase in the number of traders, 115 per cent more than before the project (FAP 12 Final Report Appendix Table J.27), also strongly supports the above statement. Therefore, traders views can be used to re-confirm the opinions of the fishermen and pond owners in Sections 7.1 and 7.2 concerning fish production trends and impacts of the Project.

During PIE study the traders stated that the quantity of fish handled per trader has declined since pre-project times by about 58 per cent in the impacted area and by 24 per cent in the control area (FAP 12 Final Report Appendix Table J.29), which may be attributed to a decrease in fish production and an increase in part-time fish traders.

Changes in abundance of various fish species in the project area as stated by traders have been outlined in Table 7.16.

The reports of the small number of traders are mixed, but their reports broadly confirm the fishermen's reports about decreases in stock and their catches, and also support the views of the pond owners on increased culture fisheries.

Most of the traders considered that the two principal causes for increased fish production were the pond fish culture expansion and the restocking of carps in beels. They also claimed that the reasons for a decline in fish stock were the blockage of fish migration routes by embankments, drying of water bodies, use of illegal nets, and fish disease.

During PIE study only recent price levels (1990/91) of different species of fish were recorded from the responses of the traders (FAP 12 Final Report Appendix Table J.33), since recall of price levels ten years previously is unlikely to be reliable. However, the price levels reported in the PIE study have been compared with those listed by DOF during 1982/83. The price levels of different species are not found to differ significantly between impacted and control areas except for major carp, hilsa and snake-heads. This probably stems from shortfalls in supply coupled with progressively greater demand for fish in the flood protected areas created by increased affluence amongst benefitting land-owners.

Table 7.16 **Changes in Abundance of Fish Species/Groups**
(Nos. of respondents reporting)

Fish Species/Group	Impacted area	Control area
Decreased		
Major carps	1	-
Hilsa	-	-
Chital/Fali	1	-
Shing/Magur/Koi (Live fish)	-	-
Snake-head	2	1
Minor carp	1	1
Shrimp	-	-
Other species	-	-
Increased		
Major carps	1	-
Shing/Magur/Koi (Live fish)	-	-
Small fish	1	-
Total respondents	3	3

Source: FAP - 12 PIE Survey

7.4 CONCLUSIONS

The Project has adversely impacted capture fisheries by reducing the areas of annual floodplains, permanent beels and khals and blocking the past fish migration routes. This consequently has resulted in a decline in the catches of fishermen and compelled many of them to leave the fishing profession or to continue on a part-time basis by adopting other additional professions such as fish trading. However, the loss is from a very high catch rate previously (compared with the control area) so that the remaining fishermen in the Project are still slightly better off than those in the control area (which may also have been affected by flood protection along the main rivers).

Although about 50 per cent of ponds within the Project area are still under flood risk, the FCD intervention has assisted in promoting culture fisheries. The increased extension activities of DOF and NGO assistance also help greatly in expanding fish culture in ponds and other perennial water bodies, and as such the annual pond fish production in this Project is exceptionally high compared with the rest of the PIE projects. This level of production can be further enhanced if the remaining flood prone ponds are protected from annual flooding which will help compensate the losses of capture fisheries to a considerable extent. The re-stocking programme of major carp seed in the annual and perennial water bodies should be strengthened through intensive and extensive extension activities by DOF and NGOs to mitigate the losses due to Project.

The relatively small sample size of the PIE study could not provide adequate and reliable information on fisheries, especially on fish traders, and so calls for further study in future project evaluation studies.

A series of standard fisheries loss figures for different types of open waters impacted by FCD projects has been synthesised by FAP 12 (see FAP 12 Final Report), and these have been applied to estimates of the changes to the flood plain and water bodies in Kurigram South in Table 7.17. These estimates alow something for impacts on the main rivers outside the Project, but also include the gains in culture fisheries since the Project. Overall the net impact is a modest loss. However, it is arguable that some of the culture fishery gain would have happened without the the Project, and hence that the project related loss may have been somewhat greater.

Table 7.17 Kurigram South - Fishery Losses and Gains

1. Area Data	
Gross area	63765 ha. (50000 ha. net)
Estimated flood land area was	9500 ha.
Area of flood land now drained	2000 ha. to 3000 ha.
Area of remaining flood land	7500 ha. to 6500 ha.
Area of beels, was about 350 ha., but now about 80 ha., i.e. loss	100 ha. - 270 ha.
Area of beels remaining	250 ha. - 80 ha.
Area of internal khals (now seasonal)	30 ha. to 30 ha.
Area of external rivers $\frac{\textit{Dharla, } 50\ km. \times 0.2 + \textit{Teesta and Brahmaputra } 60\ km. \times 0.5}{2}$	2000 ha. to 2000 ha.
2. Fishery Losses	
a) Floodplain fully drained @ 37 kg./ha.	74 mt. to 111 mt.
b) Floodplain still flooded @ 20 kg./ha.	150 mt. to 130 mt.
c) Perennial beels drained @ 400 kg./ha.	40 mt. to 108 mt.
d) Beel areas remaining @ 150 kg./ha.	37 mt. to 12 mt.
e) Internal khals etc. @ 15 kg./ha.	0.5 mt. to 0.5 mt.
f) External rivers @ 15 kg./ha.	30 mt. to 30 mt.
	331 mt. to 391 mt.
3. Culture Fishery Gains	
240 ha. of ponds (RRA estimates), now producing @ 2000 kg./ha. instead of 1000 kg./ha.	240 mt. to 240 mt.
4. Net Loss	
Low	High
91 mt.	151 mt.

8 IMPACT ON NON-FARM ECONOMIC ACTIVITIES

8.1 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 with non-farm activities. However, since these effects are mostly indirect, and given that there always exist so many variables influencing the changes, there are serious problems in segregating the impacts attributable fully or directly to the projects.

However, during the RRAs first hand information was gained about trends, through direct observation and interviews with informed sources. During the PIEs short case studies were undertaken in each of the PIE areas in order to substantiate the findings obtained during RRAs and to have further insights into aspects of changes.

During case studies the key aspects investigated were: level (number of units) of activities, seasonality, employment (annual person days worked), production, income and demand. Non-farm activities are essentially the small and rural industrial activities. Hence this chapter does not considered activities under fishing, livestock and forestry - the subsectors which fall in agriculture in the broader sense of the term which are the subject of Chapters 5-7. However, trading activities (such as dealing in rice and agricultural inputs), shop keeping and transport businesses (rickshaw, van, boat) are covered. Given that there are a wide range (more than 60) of non-farm activities, this posed problems in selecting the sample. We have, hence, purposively selected the sample to cover most of the major activities, and thus the sample is believed to be representative of the non-farm economy as a whole (but does not include activities in the urban centres within the Project area).

However, since non-farm activities vary widely in capital, scale, capacity and employment, and given that the sample was small and the survey was brief, it has not been possible in many cases to perform like-with-like comparisons. In view of this, the information provided in some of the tables is indicative and provides only a general picture of the state of non-farm activities in the areas concerned. Annual return figures are standardised as the "per family labour return of the enterprises" since imputing a wage rate for family labourers (most of whom are part-time workers and remunerated at levels well below the market wage) is unrealistic and gives very low or negative financial profits.

The case study of Kurigram South was conducted in both impacted and control areas. In all, 31 enterprises were interviewed, of which 15 were in the impacted area and 16 in the control area. Because of the purposive nature of sampling, we have refrained from doing statistical analysis and tests. Table 8.1 shows the distribution of enterprises by type and by age. It may be mentioned that relatively older enterprises were purposively selected in order to obtain information on the pre-project situation for comparison with the post-project situation. Hence, most of the enterprises surveyed were established before the Project was completed. The average age of the enterprises is about 20 years for the impacted area and 18 years for the control area. Table 8.1 reveals considerable age variation among the enterprises. On average the traditional craft enterprises and rickshaw repairing are relatively older than other types.

Table 8.1 Sample Enterprises by Type and Years of Operation

Activities	No. of units established							
	Impacted				Control			
	Before	After	Total	Avg. age	Before	After	Total	Avg. age
Rice milling	1	-	1	10	1	-	1	10
Wood, Cane & bamboo works	2	-	2	25	1	1	2	19
Saw mill	-	-	-	-	1	-	1	12
Furniture making	-	-	-	-	1	-	1	12
Oil crushing	-	1	1	8	-	-	-	-
Pottery	-	-	-	-	1	-	1	60
Blacksmithy	1	-	1	31	1	-	1	26
Goldsmithy	1	-	1	60	1	-	1	10
Tailoring	1	-	1	20	1	-	1	20
Rickshaw repairing	1	-	1	21	1	-	1	24
Stationary/Grocery	1	-	1	10	1	-	1	11
Rice trading	2	1	3	21	3	-	3	16
Rickshaw/Van transport	2	-	2	11	1	-	1	12
Boatmen	-	1	1	3	1	-	1	10
All	12	3	15	20	15	1	16	18

Source : PIE Case Studies

8.2 OVERALL PROJECT IMPACT

Based on the RRA findings, and on the PIE case study of rural enterprises, an attempt has been made to scale the degree of impact which Kurigram South has made on various nonfarm activities. In scaling the impact changes in the key variables (level of activities), annual person-days worked, seasonality, production, income and demand for products) have been taken into account. The scale of impacts (positive or negative) is as follows :

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

The scale of "overall impact" is as follows :

0- <5	- nil or negligible impact
5- <1	- minor impact
10-<15	- moderate impact
15+	- major impact

Hence it was estimated that Kurigram South has had the following scales of impact on the ten major non-farm activities :

Rice milling	+1	Agricultural input marketing	0
Wood, cane & bamboo products	0	Rice trading	0
Furniture & Carpentry	0	Rickshaw Van	+1
Blacksmithy	+1	Water transport	0
Light engineering	+0	Earth-work	+1
		Overall impact	+4

Thus, Kurigram South is assessed as having made a negligible positive impact on non-farm activities.

8.3 LEVEL OF ACTIVITIES

The Kurigram South area is not rich in non-farm activities. However, there are activities based on local resources and skills and carried out as cottage industries; these include, among others, rice milling, wood and bamboo products, pottery, trading and transport.

8.3.1 Rice and Oil Milling

As in other study areas, intensification of paddy production (mostly due to small scale irrigation and not the Project) has given rise to mechanised rice milling in the Project area. Small husking mills run on a part-time basis and in off-seasons have also emerged. However, these small hullers are usually powered by STW engines and their spread is correlated with the use 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, in oil presses, especially the manually operated units, have declined in the Project presumably because of a general decline in oil seed production in the Project area. The replacement of oilseeds by Boro, however, is not primarily due to the Project.

8.3.2 Output and Input Trading

Trading in general has increased but rice trading has not. The number of 'Kutials' engaged in processing of rice also appears not to have increased. With the increased use of agricultural inputs such as fertilizers, seeds and pesticides, trading in such items has registered a marked increase, but relative to control areas the growth in the impacted areas has been nil or negligible.

8.3.3 Agricultural Tools and Implements

Production of agricultural tools and implements made of wood and bamboo, in the form of containers, winnowers, hoes, yokes and ploughs, appears to have shown negligible growth. However, the increased intensity of cultivation has apparently increased the demand for agricultural tools and implements produced by blacksmiths.

8.3.4 Transportation

The improvement in communication created along the embankments themselves and by a large number of link roads has facilitated a widespread increase in the number of simple low-cost transports like rickshaws and rickshaw-vans. However, pre-project the area already had a good road communications network, and while construction of the embankment has further improved this, the impact is not that great. The number of boatmen in the Project area appears to have fallen slightly, but in the periphery the number has increased.

8.3.5 Overall Level of Activities

Apart from RRA and case study findings, Table 8.2, based on the community survey conducted during the PIE, gives some additional information on the growth of a few selected non-farm activities. As can be seen from the table, although there have been considerable increases in the number of rice mills and agricultural input traders, there has been no positive growth relative to control areas in these activities. With the increased use of mechanised irrigation and cultivation in the Pproject, the number of engineering workshops, catering for spares and maintenance has increased considerably, but the overall growth in the impacted area, again relative to in the control area, has not been positive. Oil press units have declined as against remarkable growth in the control area. Saw mills, however, have increased in the Project area, against no growth in the control area.

Table 8.2 Growth of Selected Non-farm Activities

Activities	No. of units					
	Impacted (24 Mouzas)			Control (12 Mouzas)		
	Before	After	Change %	Before	After	Change %
Rice Mill	3	21	+600	2	26	+1200
Oil Press	12	9	-25	5	9	+80
Saw Mill	2	3	+50	1	1	Nil
Light Engg. Workshop	1	4	+300	2	9	+350
Ag. Input marketing	10	23	+130	3	10	+233

Source : Community Survey.

8.4 SEASONALITY OF PRODUCTION

Tables 8.3 and 8.4 show the distribution of selected enterprises by annual duration of their activities, for impacted and control areas respectively. The tables show that 10 out of 11 enterprise types (91 per cent) in the impacted areas, and 11 out of 13 enterprise types (85 per cent) in the control areas are presently run year round. Almost none of the enterprises in the impacted area have shown any change in the annual length of operation at present compared to that in the pre-project period; the only exceptions are for rice milling and rice trading which show some increase in their length of working months. There is, however, no difference in the length of working months in any activity in the control areas. More importantly the project has failed to achieve any increase in the duration of the peak periods for these businesses.

Table 8.3 Period of Operation of Activities by Peak and Lean Season - Impacted Area

Activities	Number of Months of Operation					
	Peak Period		Lean Period		Total	
	Before	After	Before	After	Before	After
Rice milling	4.0	4.0	5.0	8.0	9.0	12.0
Cane & bamboo works	6.4	6.0	6.0	6.0	12.0	12.0
Saw mill						
Oil crushing	NA	2.0	NA	10.0	NA	12.0
Pottery						
Blacksmithy	3.0	3.0	9.0	9.0	12.0	12.0
Goldsmithy	2.0	2.0	10.0	10.0	12.0	12.0
Tailoring	2.0	2.0	10.0	10.0	12.0	12.0
Rickshaw repairing	2.0	2.0	10.0	10.0	12.0	12.0
Stationary/Grocery	7.0	7.0	5.0	5.0	12.0	12.0
Rice trading	5.5	3.5	3.0	8.5	8.5	12.0
Rickshaw/Van transport	2.5	2.5	9.5	9.5	12.0	12.0
Boatmen	NA	4.0	NA	-	NA	4.0

Source : PIE Case Study.

Table 8.4 Period of Operation of Activities by Peak and Lean Season - Control Area

Activities	Number of Months of Operation					
	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
Cane & bamboo works	3.0	3.0	3.0	3.0	6.0	6.0
Saw mill	4.0	4.0	8.0	8.0	12.0	12.0
Furniture making	4.0	4.0	8.0	8.0	12.0	12.0
Pottery	7.0	7.0	5.0	5.0	12.0	12.0
Blacksmithy	5.0	5.0	7.0	7.0	12.0	12.0
Goldsmithy	4.0	4.0	8.0	8.0	12.0	12.0
Tailoring	3.0	3.0	9.0	9.0	12.0	12.0
Rickshaw repairing	6.0	5.0	6.0	7.0	12.0	12.0
Stationary/Grocery	4.0	4.0	8.0	8.0	12.0	12.0
Rice trading	3.3	3.3	8.7	8.7	12.0	12.0
Rickshaw/Van transport	5.0	5.0	7.0	7.0	12.0	12.0
Boatmen	4.0	4.0	0.0	0.0	4.0	4.0

Source PIE Case Study.

8.5 EMPLOYMENT

There appear to have been negligible Project impacts on employment in non-farm activities. Employment in rice milling in general, and small rice hullers in particular, has not grown much and is not attributable fully or directly to the Project. As elsewhere, the traditional method of rice husking by dheki has been in sharp decline. In consequence, some disadvantaged women (even some landless men) have lost work. However, rice trading has largely been able to compensate this through re-employing those women in rice boiling and drying. Short-term employment opportunities have been created during construction and excavation and some additional employment has been created for unskilled labourers in earthworks, but since maintenance of infrastructure has been inadequate employment in earthworks has remained limited. Like most other FCD/I Projects, the Project has limited employment opportunities in navigation, but this has largely been offset by increased employment along the adjacent rivers.

Tables 8.5 and 8.6 give some information on the trend of changes in annual working days for selected non-farm activities. Some of the activities in the impacted areas have shown an increase in working days, compared to the pre-project situation; notably rice mills (+56 per cent), blacksmithing (+25 per cent), grocery shops (+12 per cent), and rickshaw transport (+13 per cent). The working days for all other activities appear to have shown no change. In the control areas, however, the working days during the post-project period appear to have increased for at least six of the activities (but not rice milling). In other words, the impact on non-farm activities in terms of working days in the Project area appears to have been negligible, although this data does not distinguish the level of employment or intensity of activity.

As is general in Bangladesh, the enterprises studied are family based enterprises. This is evidenced by Tables 8.7 and 8.8. Most of the enterprises in the impacted areas employ one to three people, and most in the control areas employ two to four people. The incidence of hired workers appears to be less in the impacted area compared to the control area.

The enterprises surveyed appear to be larger in the control area than the Project area in terms of total days of employment, with the exceptions of wood and bamboo products, rickshaw repairing, and boatmen. However, this is based on a few case studies and may not be representative of the industries as a whole.

Table 8.5 Days of Operation of Activities by Season - Impacted Area

Activities	Days of operation during						
	Peak Period		Lean Period		Year round		Change (%)
	Before	After	Before	After	Before	After	
Rice milling	100	112	100	200	200	312	+56
Wood, Cane & bamboo works	175	180	105	105	280	285	+2
Saw mill							-
Furniture making							-
Oil press	50	50	200	200	250	250	-
Pottery							Nil
Blacksmithy	70	90	133	180	203	270	+25
Goldsmithy	50	50	200	200	250	250	Nil
Tailoring	36	40	150	150	186	190	+2
Rickshaw repairing	60	60	300	300	360	360	Nil
Stationary/Grocery	196	210	125	150	321	360	+12
Rice trading	138	94	115	156	253	250	-1
Rickshaw/Van transport	62	70	168	190	230	260	+13
Boatmen	NA	120	NA	0	-	120	-

Source : PIE Case Studies

Table 8.6 Days of Operation of Activities by Season - Control Area

Activities	Days of operation during						
	Peak Period		Lean Period		Year round		Change (%)
	Before	After	Before	After	Before	After	
Rice milling	120	120	240	240	360	360	Nil
Wood, Cane & bamboo works	60	75	39	45	99	120	+21
Saw mill	80	88	96	120	174	208	+20
Furniture making	120	120	240	240	360	360	Nil
Oil Press							-
Pottery	210	210	75	75	285	285	Nil
Blacksmithy	120	140	140	175	260	315	+21
Goldsmithy	88	100	120	160	208	260	+25
Tailoring	90	90	270	270	360	360	Nil
Rickshaw repairing	150	140	120	154	270	294	+9
Stationary/Grocery	120	120	224	224	344	344	Nil
Rice trading	87	87	183	192	270	279	+3
Rickshaw/Van transport	110	140	140	154	280	294	+5
Boatmen	80	100	0	0	80	100	+25

Source : PIE Case Studies

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Table 8.7 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	312	312	624
Wood, Cane & bamboo works	2.0	1.5	3.5	570	428	998
Saw mill	-	-	-	-	-	-
Furniture making	-	-	-	-	-	-
Pottery	-	-	-	-	-	-
Oil press	1.0	-	1.0	250	-	250
Blacksmithy	1.0	-	1.0	270	-	270
Goldsmithy	3.0	-	3.0	750	-	750
Tailoring	3.0	-	3.0	570	-	570
Rickshaw repairing	1.0	1.0	2.0	360	360	720
Stationary/Grocery	1.0	-	1.0	360	-	360
Rice trading	1.0	-	1.0	250	-	250
Rickshaw/Van transport	1.0	-	1.0	260	-	260
Boatmen	1.0	3.0	4.0	120	360	480

Source : PIE Case Studies

Table 8.8 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	3.0	4.0	360	1080	1440
Wood, Cane & bamboo works	1.0	-	1.0	120	-	120
Saw mill	1.0	5.0	6.0	208	1040	1248
Furniture making	1.0	2.0	3.0	360	720	1080
Pottery	4.0	-	4.0	1140	-	1140
Oil press	-	-	-	-	-	-
Blacksmithy	2.0	-	2.0	630	-	630
Goldsmithy	1.0	3.0	4.0	260	780	1040
Tailoring	1.0	1.0	2.0	360	360	720
Rickshaw repairing	2.0	-	2.0	588	-	588
Stationary/Grocery	2.0	2.0	4.0	688	688	1376
Rice trading	1.7	-	1.7	474	-	474
Rickshaw/Van transport	2.0	-	2.0	588	-	588
Boatmen	2.0	-	2.0	200	-	200

Source : PIE Case Studies.

8.6 PRODUCTION AND INCOME

The respondent entrepreneurs were asked if production and incomes had changed compared with the pre-project period, Table 8.9. The resultant changes (positive or negative) in production and income have been weighted with corresponding individual figures in the last column of the table. More enterprises in the control areas reported an increase in both production and income. Hence, there has been a marked difference in the actual overall production increase (of all types of enterprises taken together) between Project and control areas (only a 5 per cent increase in the impacted area as against a 26 per cent increase in the control area. As regards overall income, again the enterprises in the impacted area have shown an increase of 9 per cent as against an increase of 21 per cent in the control area.

Table 8.9 Changes in Production and Income from Non-farm Activities (Compared to Pre-project Period)

Item	Area	% of enterprises reporting			Actual change (%)
		Increase	Decrease	Same	
Production	Impacted	71.4	21.4	7.1	+5.2
	Control	87.5	6.3	6.3	+26.1
Family Income	Impacted	71.4	21.4	7.1	+9.3[1]
	Control	87.5	6.3	6.3	+20.9[1]

[1]Family Income = Value of output minus all costs including wage bill for hired labourers

Source : PIE Case Studies

Table 8.10 presents information on per enterprise annual income, in 1990-91, from selected non-farm activities. Since the enterprises under study vary widely in capital, scale and employment, and not all types of enterprises are common in the sample of both impacted and control areas, the income figures over the impacted and control areas are not comparable. However, the income figures standardised as per family labour return show that per family labour income level from the enterprises, in general, is higher in the impacted area, compared to the control area; the only exceptions are the activities of goldsmithy, grocery shops and boatmen.

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Table 8.10 Per Enterprise Annual Family Income from Selected Non-farm Activities

Activities	Annual[1] family income (Tk.)		Annual income per family labour	
	Impacted	Control	Impacted	Control
Rice milling	84080	13600	84080	13600
Wood, Cane & bamboo works	26531	10248	13266	10248
Saw mill	-	22000	-	22000
Furniture making	-	12600	-	12600
Pottery	-	52750	-	13188
Oil press	39606	-	39606	-
Blacksmithy	51045	33350	51045	16675
Goldsmithy	44010	43860	14670	43860
Tailoring	48330	7800	16110	7800
Rickshaw repairing	15300	11960	15300	5980
Stationary/Grocery	14110	48360	14110	24180
Rice trading	24004	30458	24004	18238
Rickshaw/Van transport	13240	11102	13240	5551
Boatmen	7400	32700	7400	16350

Note : [1]Based on previous 12 months (1990-91)

Source : PIE Case Studies

8.7 PERCEPTIONS OF BENEFITS FROM THE PROJECT

During the case study, the entrepreneurs' perceptions of benefits from the Project were recorded. Table 8.11 shows that 13 out of 15 (87 per cent) enterprises of the impacted area mentioned that they have benefited from the Project. Less than half of the benefited enterprises appear to have benefited by way of easy transportation, which contrasts with the general view of farmers and landless that transport has improved (Section 10.8.2). However, about 70 to 77 per cent of the enterprises mentioned that they have benefited by way of increased supply of raw materials and increased demand for output.

Table 8.11 Respondents' Perceptions of Benefits from the Project (Towards Development of Non-farm Activities)

Type of benefit	% of benefited respondents
Eased transportation of raw material and output	46
Increased supply of raw material	69
Increased demand for output	77
Benefited enterprise	13
% benefited	87

Source : PIE Case Studies

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8.8 DAMAGE BY 1988 FLOOD

The Project appears not to have reduced the risk of damaging floods (affecting infrastructure and rural industry), and in 1988 enterprises in the Project area reported more damage than those outside the Project (which is in contrast with domestic damages which appeared to be lower inside the Project in 1988 - fewer households but a similar level of damages Section 10.7.3).

Table 8.12 shows that in the devastating 1988 flood out of 15 enterprises in the impacted area 4 (27 per cent) suffered losses, as against 3 out of 16 (19 per cent) in the control area. Also, the extent of losses per enterprise was higher inside the Project (Tk.574 per enterprise) than in the control areas (Tk.163 per enterprise). This may be because those inside the Project 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. However, the sample is small, hence it cannot be concluded that damages were significantly higher in the Project area in an extreme flood.

Table 8.12 Damage Caused by 1988 Flood

Area	Total Sample	No. of units affected by 1988 flood	%	Per enterprise[1] amount of damage on account of					
				Structure	Machinery	Raw material	Output	Working days	Total
Impacted	15	4	27	27	-	3	52	492	574
Control	16	3	19	-	-	-	-	163	163

Note [1] averaged over all enterprises

Source : PIE Case Studies

8.9 CONCLUSION

Hence it would appear from the case studies that there has been little development of secondary economic activities as a result of the Project - the trends are similar overall in Project and control areas. It seems likely that the Project has helped, but the area was relatively underdeveloped in the first place, and the primary impacts (in hydrology, agriculture and fisheries) have not been large. Hence the impacts on non-farm activities appear consistent with the primary impacts, and also with the general socio-economic and economic impacts.

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9 GENDER IMPACT

9.1 INTRODUCTION

9.1.1 Limitations

Flood control measures may affect women and their roles relative to men in several ways. The pattern and degree of effects on women are likely to vary with the types of household (farm, labour, fisherman). The outcome of any process involving women depends not only on the process itself but also on tradition and social factors, this makes the final outcome rather uncertain. Therefore, it is not possible, without a through investigation, to clearly understand the impact of FCD/I projects on women's lives. The following analysis and description, therefore, only try to outline 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.

9.1.2 The Areas of Investigation

The analyses that follow fall into four broad areas:

- nature of women's involvement in household and outside work;
- activities related to homestead production;
- nutritional issues; and
- problems faced by women during severe floods.

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

9.2 NATURE OF WOMEN'S INVOLVEMENT IN HOUSEHOLD AND OUTSIDE WORK

9.2.1 Hiring of Women

Households in Kurigram have been found to be involved both in hiring-in and hiring-out of women labourers. However, hiring-out of women from farm households is very rare in both impacted and control areas (Table 9.1). It should also be noted that the incidence of hiring-in of women is not very high (18 per cent in impacted and 30 per cent in control areas) even among farm households. In contrast to farm households, hiring-in of women is absent in labour and fishermen households, and the incidence of hiring-out women labourers is much higher.

In Kurigram there has been a small gain in paddy production due to the Project, and a further gain from small scale irrigation, which has created a need for farmers to hire-in more labours. However, there is little difference between impacted and control areas in the incidence of hiring-out of women from labour households. Kurigram is generally a depressed area with a very high incidence of poverty among labour households, hence one finds a high incidence of women working outside the home. Similarly among fishermen's households hiring-out of women is high both in control and impacted areas.

Table 9.1 Employment of Women in All Activities in Kurigram South

Type of household	Hire in		Hire out		No of H/H Surveyed	
	Impacted	Control	Impacted	Control	Impacted	Control
Farmer	11 (18)	11 (30)	0 (0)	1 (3)	62	37
Labourer	0 (0)	0 (0)	11 (44)	7 (50)	25	14
Fishermen	0 (0)	0 (0)	7 (47)	6 (40)	15	15
All	11 (11)	11 (17)	18 (18)	14 (21)	102	66

Note: No. of respondents, figures in parentheses indicate percentage of all respondents
Source: PIE Household Survey

9.2.2 Agricultural and Non-Agricultural Work

Women of the farm households are involved in various agricultural activities, particularly those related to crop processing. Naturally women from non-cultivating households do not do agricultural work for the household, and likewise in fishing households which have hardly any cultivated land. For non-agricultural work the opposite generally holds true: while practically no woman from the farm households work in non-agricultural activities, about 20 per cent work outside agriculture in other categories of household. In Kurigram area proportionately more are involved in non-agricultural activities in the control area (26 per cent) compared to the impacted area (19 per cent).

9.2.3 Sexual Division of Work in Agricultural Activities

The responsibilities of men and women in agricultural operations were generally clear-cut prior to the Project. Men were mostly involved in field activities during pre-harvest and harvesting periods (Table 9.2). Mostly, and not surprisingly, women's work was confined within the household. They were thus involved in seed preservation, parboiling, husking and storage of paddy, and to a lesser but still considerable extent in threshing of paddy. In threshing they shared the burden mostly with men, but in parboiling and husking a few women from outside were also employed. In the impacted area parboiling is a job done by women only, otherwise the patterns were the same for both the impacted and the control areas.

The Project did not affect the basic sexual division of work but the change in agricultural output has created some opportunities, although small, for hired women to be employed more in activities like threshing and parboiling in the impacted area. This did not happen in the control area.

In the case of husking the work burden of women has fallen compared to the pre-Project situation. Men are now found to be engaged more frequently in husking than before both in impacted and control areas. This reflects the increase in mechanised husking due to the use of STW engines during the off-season (Section 8.3.1). The responsibility of taking

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paddy to the mill also falls to men, further increasing their role in husking. This could be termed as a Project impact only to a very limited extent.

Table 9.2 Role of Women and Men in Agricultural Work in Farm Households in Kurigram South (percentage of households)

Activity type	Impacted						Control					
	F. Women		H. Women		Men		F. Women		H. Women		Men	
	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After
Seed pres.	96.8	95.2	1.6	1.6	25.8	25.8	94.6	94.6	8.1	8.1	37.8	37.8
Pre-harvest	4.8	8.1	-	-	98.4	98.4	2.7	2.7	-	-	100.0	100.0
Harvest	-	1.6	-	-	98.4	98.4	-	-	-	-	97.3	100.0
Threshing	83.8	80.6	12.9	14.5	96.8	96.8	67.6	67.7	16.2	13.5	89.2	89.2
Parboiling	95.2	95.2	11.3	14.5	-	-	97.3	94.6	24.3	24.3	8.1	8.1
Husking	91.9	82.3	17.7	9.7	11.3	32.3	86.5	81.1	24.3	24.3	21.6	43.2
Storage	98.4	98.4	3.2	4.8	11.3	11.3	100.0	97.3	16.2	18.9	18.9	18.9

Source: PIE Household Survey

9.2.4 Change in Agricultural Activities of Women Family Members in Farm Households

The direction and the magnitude of change in the work burden of women in agricultural activities may be influenced by several factors. In the case of Kurigram area increased paddy production will demand more of women in most of the activities in which they are involved. The actual outcome in case of family women will, of course, depend on how much of the additional load is shared by either men or hired women labourers. There is no prior hypothesis about such substitution and the final outcome may, therefore, be judged solely on observation.

The data from Kurigram indicate that the situation is rather mixed. In the impacted area more women appear to have experienced a decreasing workload than those who have experienced an increase (Table 9.3), particularly in parboiling and husking. The same trend is apparent in parboiling, husking and shortage in the control area but to a lesser extent. Hence changes in the Project area may have relieved household women of work but also reduced paid work for poor women hired in by other households.

Among those who could identify the reasons for change in the workload of women of the impact area, practically all (94 per cent) ascribed it to higher output. Those who identified reasons for decrease clearly identified land loss, husking machines, problems caused by flood, water logging and excessive rain as the most important reasons.

9.3 HOMESTEAD PRODUCTION

9.3.1 Number and Types of Trees.

The average number of trees and plants per household have increased in both the impacted and control areas; but more so in the latter compared to the pre-project situation (Table 9.4). The farmer households have the highest number of trees as they have more land in and around the homestead. A reduction in the number of trees was found among fishermen households of both areas, but this decline is greater in the control area. Without additional information it is difficult to explain the differences between impacted and control areas and among occupational groups.

Table 9.3 Changes in Activities of Family Women in Agricultural Operations in Farm Households (percentage households)

Activity type	Impacted		Control	
	Increased	Decreased	Increased	Decreased
Seed pres.	14.5	16.1	8.1	5.4
Pre-harvest	1.6	0.0	0.0	0.0
Threshing	1.6	11.3	0.0	0.0
Parboiling	17.7	59.7	13.5	43.2
Husking	1.6	43.5	5.4	29.7
Storage	17.7	24.1	2.7	27.0
Sample	62		37	

Source: PIE Household Survey

Various types of trees are grown in the homesteads. The proportion of fruit bearing trees increased in both areas (from 42 per cent to 53 per cent in the impacted area and 42 per cent to 58 per cent in the control areas).

Table 9.4 Average Number of Trees in and Around Homesteads in Kurigram South

Household type	Impacted		Control	
	Before	After	Before	After
Farmer	83	96 (16)	61	96 (57)
Labourer	28	32 (14)	4	10 (150)
Fishermen	25	20 (-20)	73	24 (-67)
ALL	61	69 (13)	52	61 (17)

Note: Figures in parenthese indicate percentage change over the pre-project situation
Source: PIE Household Survey

9.3.2 Sexual Division of Work in Caring for Trees

In Kurigram women have been found in general to be involved in tree-growing activities only in association with men, except for fuel wood/leaf collection. Men are involved in all activities except tree-care and fuel wood collection; planting of trees and tree-felling are almost exclusively their reserve. The only exception to this norm is the fishermen group of the control area (as much as 40 per cent of women were involved in tree-felling in this group).

The change over time in the relative role of men and women in caring for trees is difficult to assess. It should be noted that in Kurigram area both the average number of trees and proportion of fruit-bearing trees have gone up. This could be used as an indicator of increase over time in the women's workload in tree planting and care. On the other hand, as the demand for fuel wood per household may at best have remained unchanged, if not increased, it may mean less time spent in collection and gathering of fuel wood outside the home.

Women are actually involved in decision making concerning homestead trees at least so far as planting and harvesting are concerned but tree felling (the permanent loss of the resource) is decided mainly by men. It is highly unlikely that the Project has affected this process.

Table 9.5 Incidence of Women's Role in Decision-making in Tree Plantation in Kurigram South

Type of household	Planting		Harvesting		Tree-felling	
	Impacted	Control	Impacted	Control	Impacted	Control
Farmer	40 (65)	14 (38)	51 (82)	34 (92)	18 (29)	4 (11)
Labourer	14 (56)	4 (29)	10 (40)	7 (50)	4 (16)	2 (14)
Fishermen	8 (53)	10 (67)	5 (33)	9 (60)	2 (13)	8 (53)
All	59 (59)	28 (42)	66 (65)	50 (76)	24 (24)	14 (21)

Note: No. and (per cent) of households with women involved in decisions
Source: PIE Household Survey

9.3.2 Vegetable Production: Incidence and Sex Roles

Tiny vegetable plots could be found at almost all households in Kurigram. From the survey it appears that among fishermen households in the impacted area there has been some reduction in the vegetable area (36 per cent over the pre-project situation). In most cases the change has occurred in the other direction: an increase in vegetable garden area. Both in the impacted and control area there has been little change in the area so cultivated by the farm households.

Vegetable gardening in the homestead is a women's domain for all practical purposes. Women receive help from men mostly in land preparation, sowing and weeding. The impacted and the control areas show little difference to this pattern.

9.3.3 Poultry Keeping: Relative Sex Roles

Women's role, whether individually or in association with men, in decision making in poultry keeping seems to be more pronounced in the impacted area than the control area except in the use of money from sale of produce. Women of the control area were more involved in decisions regarding the use of the money they make from poultry keeping.

9.3.4 Homestead Income and Its Use

Table 9.6 shows the estimated income per household by type of source and type of household for the impacted and control areas. Average homestead income appears to be higher in the control area compared to the impacted area. Other than that, there seems to be little difference in the composition of income in terms of source. Both in the impacted and control areas poultry seems to be the major source of income.

Table 9.6 Average Returns from Homestead Production
(Tk/household/annum)

Household type	Impacted				Control			
	Veg.	Pty.	Egg	All	Veg.	Pty.	Egg	All
Farmer	214 (20)	557 (53)	289 (27)	1060 (-35)	474 (29)	805 (49)	362 (22)	1641
Labourer	66 (15)	231 (53)	140 (32)	436 (-18)	89 (17)	270 (51)	174 (33)	532
Fishermen	84 (32)	129 (48)	52 (19)	265 (-37)	83 (20)	150 (36)	186 (44)	418
All	159 (20)	414 (52)	217 (28)	790 (-30)	303 (27)	542 (48)	282 (25)	1128

Note: Figures in parentheses in the 'impacted all' column are percentage difference over the control area returns. In all others these indicate percentage contribution of source by area and type of household.
Veg. - Vegetables Pty. - Poultry

Source: PIE Household Survey

It should also be noted that it is the farmers who gain most from homestead production. There may be several reasons for that. For example, their homstead plots are comparatively larger, and they can raise more chicken and ducks which are better fed and cared for because of the crop production of such households. Also, women in farm households, being freed in many cases from the arduous job of husking, may have more time for raising poultry.

It is difficult to make any comment on the general pattern of sex-differences in receipt of sale money since very few households were involved in such activities. In most cases homestead income accrues in kind and practically all of it is consumed by the household. Therefore, almost all who answered the question on the use of the homestead income identified it as being mainly spent for the household. Practically no one spent it for personal purposes.

9.3.5 Group Activities

Very few women were found to be involved in group activities (about 17 women in total). A majority of these are from fishermen households (3 in the impacted and 6 in the control area).

9.4 NUTRITIONAL ISSUES

9.4.1 Caveats

It was hoped that a rise in income of the people living within the Project area would lead to better nutritional status of the households. As a full-fledged nutritional survey was not possible within the scope of this study, questions were only asked on the level of intake of the most frequently consumed foods (rice, wheat, parched rice and pulses), and attempts were made to draw forth women's ideas about the adequacy of food intake by various family members. In addition gender differences in rice consumption were investigated.

In rural Bangladesh nearly 84 percent of the total calorie intake comes from the four types of food mentioned above (BBS; 1991). Total calorie and protein consumption in the sampled households were estimated using this ratio. It should be noted that the timing of the fieldwork for these investigations may have resulted in seasonal biases in the estimates. Also in Kurigram, the field work coincided with a sudden flood and a lack of employment among labouring households. Therefore, it is quite likely that the estimates made by us will show a downward bias.

9.4.2 Food and Calorie Intake

The estimated average per capita consumption of rice and calories are shown in Table 9.7. From the table it appears that the households in the impacted and control areas have similar intakes. Farming households have higher calorie and rice intakes which correlates with their higher incomes (Section 10.4). However Project area farm households appear to have lower food consumption but higher average incomes, this may be biased by the September 1991 flood.

9.4.3 Poverty Profile

A categorisation of households on the basis of the level of calorie intake was constructed and is presented in Table 9.8. The households are divided into three groups:

- those who consume at most 1805 Kcal/person/day are classified as hard core poor;
- those who consume between 1805 and 2122 Kcal/person/day are classified as absolute poor; and
- those consuming over 2122 Kcal/person/day are classified as non-poor.

Table 9.7 Per Capita Daily Rice and Calorie Intake in Kurigram South

Household type	Rice (gms)		K calorie	
	Impacted	Control	Impacted	Control
Farmer	467 (-10)	519	2198 (-8)	2395
Labourer	341 (14)	299	1573 (7)	1472
Fishermen	379 (-16)	450	1857 (-15)	2174
All	428 (-8)	467	2017 (-8)	2187

Note: Figures in parentheses indicate percentage differences over control
Source: PIE Household Survey

Table 9.8 shows that in general the sample households in the control area are somewhat better-off than the impacted area in terms of calories consumed by the households for each occupational group. The proportion of non-poor households is much higher among farmers and fishermen in both areas (46-57 per cent) than among labouring households. In both areas it is the labour households who suffer most from nutritional poverty and the majority (above 50 per cent) of them can be classified as hard core poor households.

Table 9.8 Percentage of Households by Level of Poverty in Kurigram South

Household type	Hard core		Absolute		Non-poor	
	Impacted (%)	Control (%)	Impacted (%)	Control (%)	Impacted (%)	Control (%)
Farmer	22.6	24.3	25.8	21.6	51.6	54.0
Labourer	52.0	57.1	32.0	21.4	16.0	21.4
Fishermen	40.0	26.6	13.3	20.0	46.6	53.3
All	32.3	31.8	25.5	21.2	42.1	47.0

Source: PIE Household Survey

9.4.4 Adequacy of Food Intake

Responses on the adequacy of food intake by family members were drawn from women respondents. A sense of deprivation is felt by almost all labour (92-100 per cent) and most fishing (67-80 per cent) households. This finding follows the pattern of replies on rice consumption. The labourers seems to be most disadvantaged in both the areas and more so in the control area.

9.4.5 Gender Difference in Food Intake

The difference in rice intake of adult men and women and that between boys and girls of about eight years of age were used as two indicators of gender difference in food intake. There is not much difference in food intake in the later group, around 12-35 gms per day more for boys. In contrast, adult women were found to consume 25-35 per cent less than adult males. This deprivation seems to be similar both in impacted and control areas.

9.4.6 Consumption of Non-grain Food

One may hypothesise that a rise in income will lead to an increase in consumption of protein foods like meat, fish, eggs and milk as income elasticity of such foods is high. Whether this is the case in the Project area has been tested in a very crude manner, by looking at the frequency of consumption of such foods. The incidence of consumption of such foods over the week preceeding the survey is presented in Table 9.9. Several conclusion can be drawn from the data presented:

- the most frequently consumed non-grain food is fish. During the reference week most farmers and all fishermen households, both in control and impacted areas, consumed fish. Although labour households are not so fortunate, still a majority of them had consumed fish in the reference week;

- in both impacted and control areas meat was less frequently consumed. Over 25 per cent of farmers consumed meat but virtually no one else ate meat in the reference week. The only exceptions to this were a few of the labourers of the impacted area;

- farmers consume eggs fairly often in both impact and control areas. Consumption of eggs is not frequent among fishermen, and virtually absent in labouring households;

- consumption of milk is most frequent among farmers (more than 40 per cent). Among fishing households its consumption is less frequent, and it is almost absent in the labour households; and

- there is virtually no Project impact, except that labouring households may eat slightly more protein in the Project area.

9.4.7 Frequency of Cooking

Most of the households in both impacted and control areas and all groups of households cook at least twice a day. Some also cook three time a day. Less than 10 per cent of people cook once a day. Therefore, it seems that very few people eat cold meals which carry a greater health risk.

9.4.8 Incidence of Starvation

Despite some growth in annual income, due to seasonal lack of employment and income people may still starve partly or fully during part of the year. When questioned about such occurrence, the responses seem to indicate some change in the proportion of households so affected before and after the Project. Among the occupation groups, farmers seem to be somewhat more fortunate than the other two groups of households (Table 9.10). The data also show that all of the fishermen households suffer from starvation during part of the year, while around 70-85 per cent of labour households have to face such an ordeal.

Table 9.9 Percentage of Household Consuming Animal Protein During the Last 7 Days

Food type	Farmer		Labourer		Fishermen	
	Impacted	Control	Impacted	Control	Impacted	Control
Meat	29	27	12	0	0	0
Fish	98	91	67	71	100	100
Egg	19	24	4	0	7	13
Milk	40	48	8	0	33	20

Source: PIE Household Survey.
Note: Survey taken place in September 1991.

Table 9.10 Percentage of Households Facing Starvation during Part of Year in Pre- and Post-Project Situation

Household type	Impacted		Control	
	Before	After	Before	After
Farmer	58	73	43	54
Labourer	68	72	86	86
Fishermen	100	100	93	100
ALL	67	76	64	71

Source: PIE Household Survey

9.4.9 Seasonality in Starvation

In rural areas starvation is related to the seasonal peaks and troughs of economic activities. Where Aman is the major paddy crop one expects a rise in dietary intake in general and a low incidence of starvation during the post-harvest period of Poush and Magh. This is a period of peak income for fishermen too because catches are good during winter while the Aman harvest keeps demand at a high level. One would except a dip again around May (Bengali months of Baishak and Jaistha) prior to the Boro harvest in places where Boro is the dominant crop.

In Kurigram, as shown in Chapter 5, the two most important crops are T. Aman and Boro in both impacted and control areas. One, therefore, would expect two dips in the seasonality of incidence of starvation - one right before and during the Boro harvest and one before and during the Aman harvest.

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Figures 9.1-9.3 confirm the above hypotheses quite well, especially in the case of farmers. For most labourers the Boro dip occurs somewhat prior to that of farmers, as farmers receive most of their income only after the harvest is over while labourers are paid at harvest. There is little difference between impacted and control areas or among occupational groups. The incidence of starvation among fishing households is at its peak during the months of Bhadra and Aswin in the impacted area and in the control area the peak it in the months of Kartik and Agrahyan (October-November). The figures also indicate that the incidence of starvation has worsened inside the Project, especially for farm households, which differs from the results of interviews with male heads of household (Section 10.6.1).

9.4.10 Adjustment Mechanisms

When the prospect of starvation looms large, people either borrow from others or try to eat less or both (Table 9.11). This is true across all groups of households and in both impacted and control areas. It is notable that the vast majority of labouring households borrow and eat less, while selling assets occurs among Project farm households suggesting they have not gained from greater food security.

Table 9.11 Percentage of Households Adopting Measures to Cope with Starvation

Type of measure	Farmer		Labourer		Fishermen		All	
	Impacted	Control	Impacted	Control	Impacted	Control	Impacted	Control
Borrowing	48	40	84	86	80	73	62	58
All ate less	47	38	92	93	73	53	62	53
Women ateless	40	40	32	43	40	47	38	44
Others ate less	2	8	4	14	13	7	4	8
Disinvestment	27	8	8	0	7	0	19	4
Others	3	3	8	7	7	13	5	6

Source: PIE Household Survey

Women seem to disproportionately share the burden of internal adjustment. In 62 per cent of households in the impacted area everyone in the family shares the hunger, but in 38 per cent women alone have to do so. The proportion (44 per cent) is similar in the control area. Hence the Project appears to have brought little improvement in food status of households, and there is no evidence that women have gained compared with control areas in terms of basic needs such as food.

9.4.11 Access to Safe Water

Data presented on Table 9.12 clearly indicate that for drinking water all households depend on safe sources (generally hand tube wells). For cooking all households in the control area and most of the households in the impacted area depend on safe sources. Use of unsafe sources for cleaning purposes is higher among the households of the impacted area, especially in the case of labour households (more than 50 per cent). Quite obviously is of no use to drink tubewell water if utensils are cleaned with water which may carry bacteria and other pollutants.

Figure 9.1 Starvation in Kurigram South (Farmers)

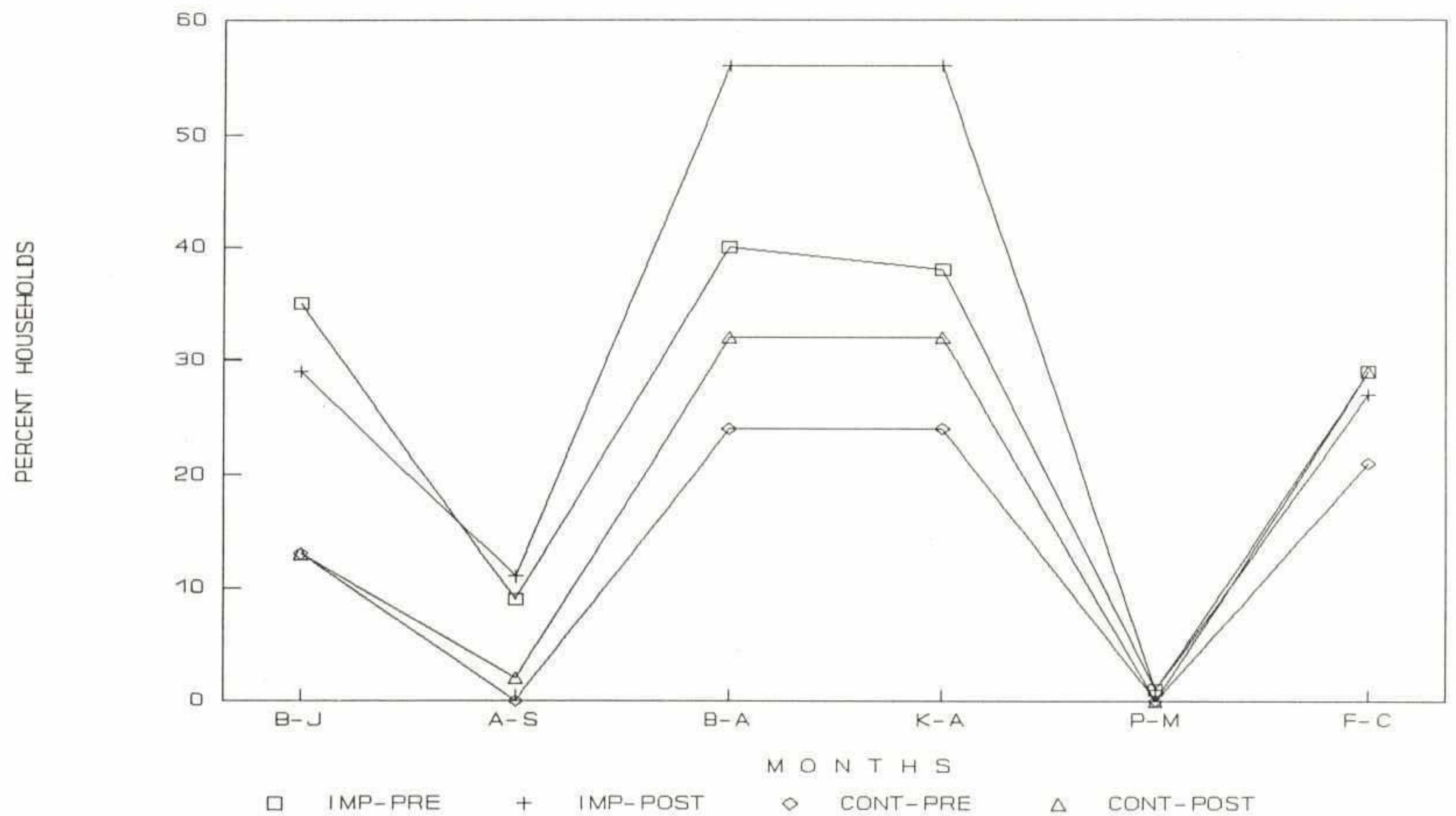

Figure 9.2 Starvation in Kurigram South (Labourers)

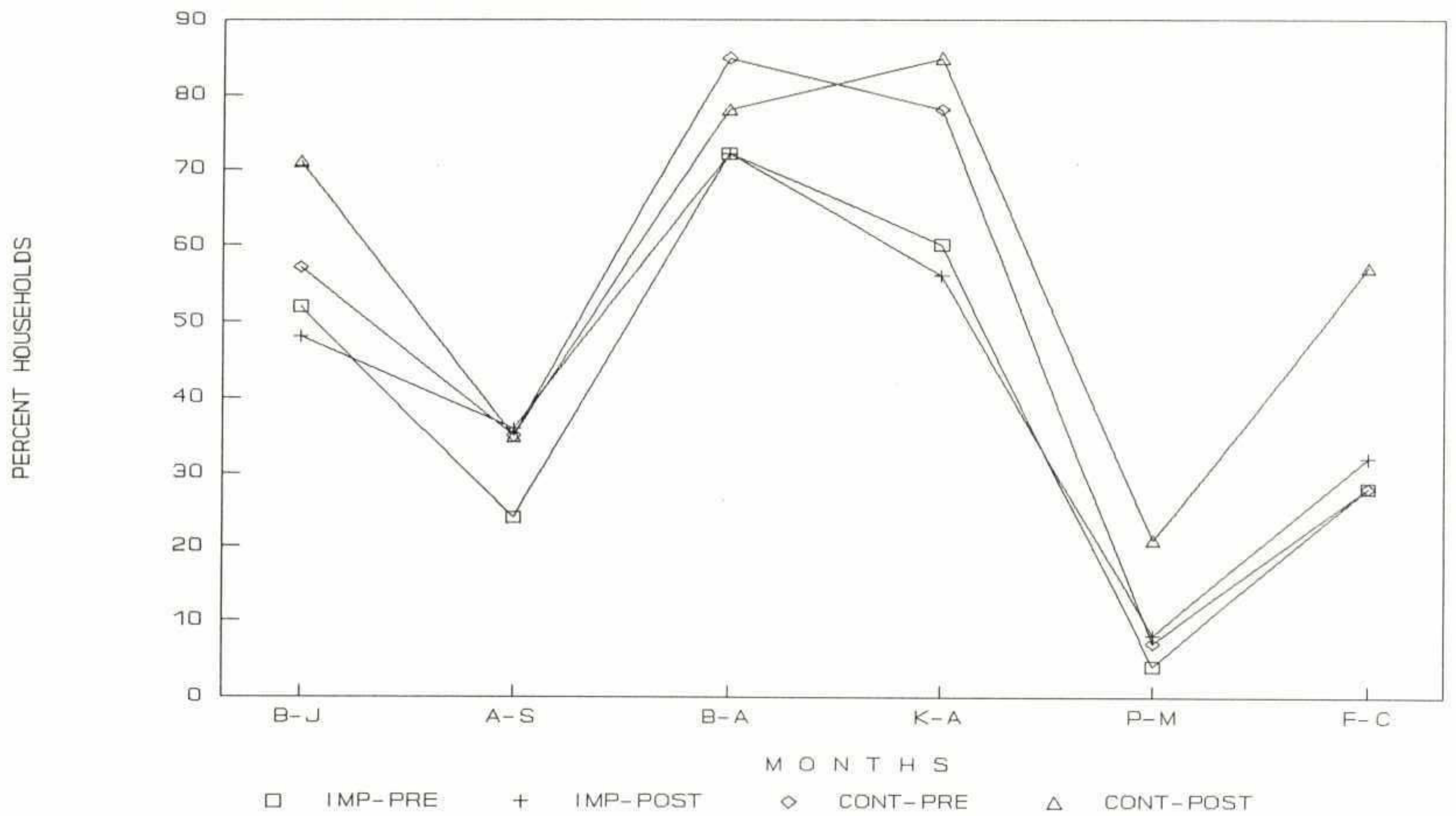

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Figure 9.3 Starvation in Kurigram South (Fishermen)

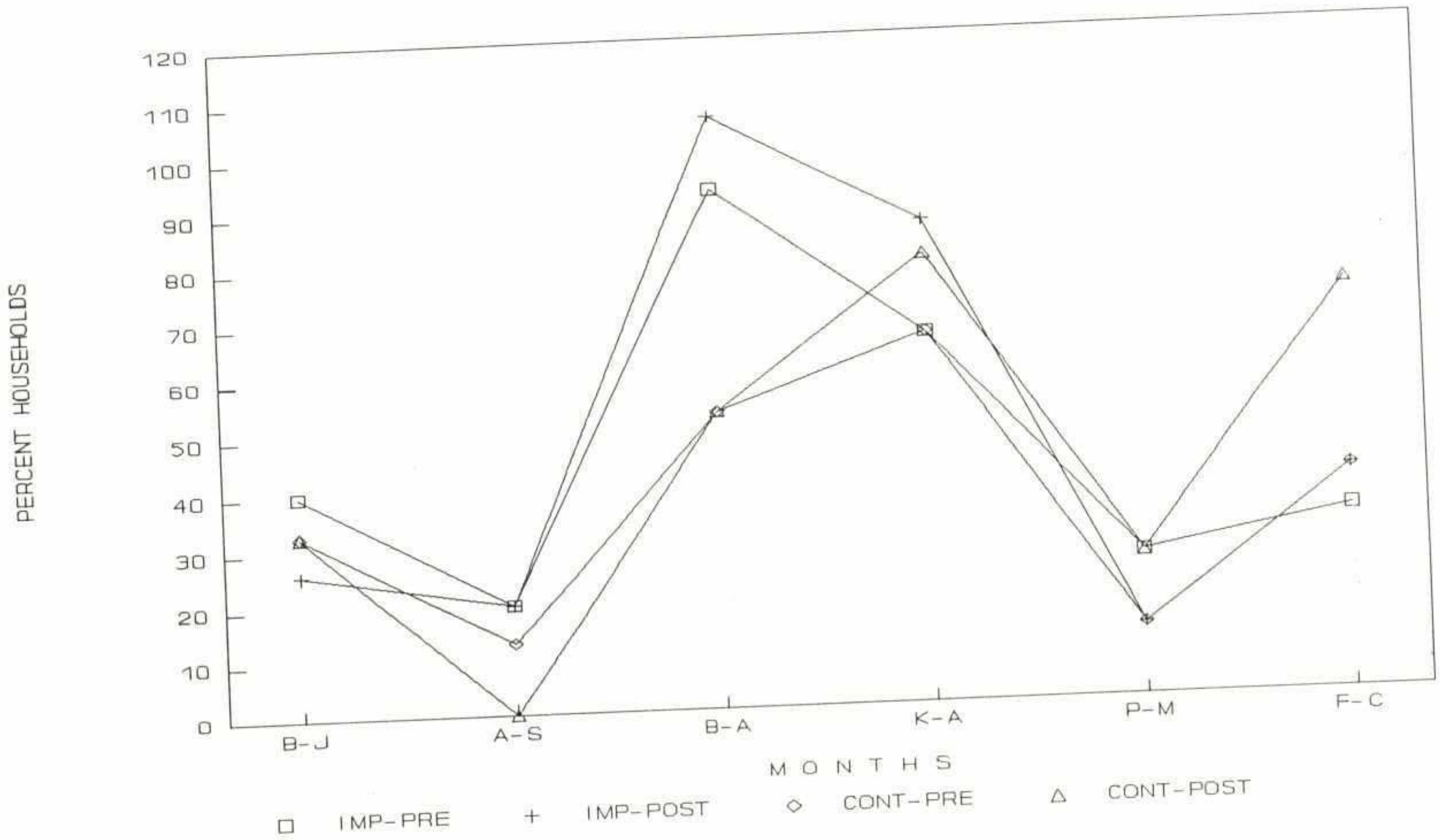

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Table 9.12 Present Sources of Water by Type of Use in Kurigram South
(percentage of households using source)

Household type	Area	Cleaning		Cooking		Drinking		N
		S	US	S	US	S	US	
Farmer	Impacted	60	40	95	5	100	-	62
	Control	62	38	100	-	100	-	37
Labourer	Impacted	48	52	100	-	100	-	25
	Control	57	43	100	-	100	-	14
Fishermen	Impacted	60	40	93	7	100	-	15
	Control	60	40	100	-	100	-	15
All	Impacted	57	43	90	4	100	-	102
	Control	61	39	100	-	100	-	66

Note: S = Safe source
US = Unsafe source
Source: PIE Household Survey

9.4.12 Problems of Water Quality and Disease

A number of women (35 per cent) in the impacted area complained about changes in water quality and incidence of disease due to such changes. But suffering from such diseases was reportedly less in the control area. Among the various types of disease mentioned by women, gastroenteric diseases are the most common, but the incidence in the Project area was lower than in the control area among adults and children (mean number of bouts of illness in last 12 months about 0.3 per household in Project and 0.5 per household in the control area).

9.5 PROBLEMS FACED BY WOMEN DURING FLOODS

Data on the problems suffered by the household due to floods, and the problems affecting women most adversely are presented in Table 9.13. Lack of toilet facilities create grave difficulties for women in the impacted area (42 per cent). Other major problems faced by women of the impacted area are problems with cooking, lack of dry space and drinking water. Among the households of the control area major problems are dry space availability, problems faced in cooking, toilet facilities and drinking water (in that order). There is no evidence of a decline in flood related problems in the Project area.

Table 9.13 Percentage of Women Facing Problems During Floods

Type of problem	Impacted	Control
Dry space	28.4	22.7
Drinking water	22.5	13.6
Toilet	42.2	19.7
Cooking	30.4	21.2
Food availability	5.9	7.6
Movement	12.7	4.5
Homelessness	0.0	0.0
No problem	10.8	22.7

Source: PIE Household Survey

9.6 SUMMARY

Overall Kurigram South Project has not been an agent of change in women's lives nor in their economic roles when compared with the control area. This is not surprising given the relatively small percentage gains to Project households over the control area in terms of agriculture and incomes.

10. SOCIO-ECONOMIC IMPACT

10.1 BACKGROUND INFORMATION

10.1.1 Study Areas

The Kurigram South Project has evolved over a long Period, with the pre-project period dating back over 10 years (work commenced in 1975 and was substantially complete by 1984 although additional works continue to be undertaken and the Project is not yet declared complete - see Chapter 2). Hence recall of pre-project conditions is particularly unreliable in this PIE, which makes the project-control comparison particularly important. A small part (21 out of 168 households) of the impacted sample come from unprotected areas adjacent to the Project, however it is important to note that these areas are environmentally very different from the protected area since they are chars which lie in the active flood plains of the Teesta and Dharla. Hence while they may have been affected by the Project they were not the same as the Project area in agro-ecological terms before the Project, and simple differences from the Project may not be attributable to it.

The Kurigram South Unit includes within its area Kurigram District Town and three Upazila towns (plus the fringe of Lalmonirhat District Town), however the surveys were restricted to rural areas since the primary focus was on agricultural impacts (of an agricultural development project) and associated changes. Hence this section does not consider socio-economic impacts on the urban population. Yet the combination of flood protection and the Kurigram Town Protection Project might be expected to also have benefited the urban population through direct flood protection of personal property, protection of infrastructure, and induced growth linked with the intended agricultural benefits (the latter has been discussed in Chapter 8).

A further general point is that the Kurigram region, a large part of which falls within the Project and control areas, is well known as a depressed area of Bangladesh and has been subject to famine and a high level of poverty. Hence the general level of socio-economic indicators might be expected to be low, but of course differences and changes would be hoped for if the Project has achieved its objectives.

10.1.2 Pre-Project Socio-economic Conditions

The RRA collected some general information on pre-project conditions which form the context for changes, Project and non-project related, found in the PIE. The area was heavily dependent on agriculture but this was a gamble in the monsoon season depending on the flow of the three main rivers bordering the Project area and the branch channels and tributaries which run through it. Hence floods were a part of life. The region was poor and a labour surplus area with low wages and many labourers migrating to the neighbouring Districts of Rangpur, Dinajpur, Bogra and Rajshahi (particularly around April and December). Women also worked as agricultural labourers but for lower wages than men.

Communications, with the exception of the railways, were poor with bullock carts widely used in the dry season and boats and launches in the monsoon. A number of local cooperative societies existed, mainly for farmers and fishermen; and a major NGO - Rangpur Dinajpur Rural Services (RDRS) was active in relief and development works.

10.2 DEMOGRAPHIC CHARACTERISTICS

Table 10.1 shows that typically family sizes are slightly smaller in the Project area than in the control, although it is unclear why this might be. Sex ratios are biased in favour of males as might be expected, while there is no real difference in dependency ratios between Project and control areas, nor between farming and labouring households. Literacy levels show no Project-control area difference, although the farmers surveyed had the highest percentages of literates in the PIE samples. There may be some Project related difference in school enrolment: a higher percentage of boys from farming households go to school inside the Project, but there is no difference among labouring households or among the girls of farming households. There is apparently a substantial gender difference in school enrolment between farming and labouring households in Project and control areas alike since the enrolment of girls is the lowest overall in the PIEs among labouring households, but is relatively high for farming households.

Table 10.1 Demographic Characteristics of Sample in Kurigram South

Project	Farmer		Labourer		Fishermen		Others	
	Imp	Cnt	Imp	Cnt	Imp	Cnt	Imp	Cnt
Family Size	6.2	7.0	4.7	5.5	5.6	4.8	6.6	7.6
Sex Ratio	114	113	117	104	115	140	130	89
Dependency Ratio	4.0	4.2	3.6	4.0	3.7	3.0	4.6	3.9
Percentage Literate Heads	62	63	19	25	40	47	67	78
% Boys at School	90	78	40	40	55	10	77	85
% Girls at school	77	76	24	11	55	65	84	76

Source: PIE Surveys

10.3 OCCUPATIONS AND EMPLOYMENT

10.3.1 Occupations

Table 10.2 summarises the employment status of the sample households - there does not appear to be any difference in the numbers of earners which might produce differences other than due to the Project in incomes. However, the incidence of secondary occupations among household heads appears to be much higher among farming and non-farming households in the Project area (these tend to be farmers who are also labourers or salaried or traders), and likewise for labourers (who also fish or do non-farm labour). Although occupations are not diverse in terms of earners who have different main occupations from the main income source of the household, there is a higher incidence of secondary occupations among all earners in the Project and not just household heads, it is not clear whether this is of necessity (because agriculture cannot support households on its own, for example), or because people take the opportunity presented by improved agriculture to diversify household income sources.

The primary occupations of the main sample were very sharply aligned as either farmers or labourers - there were no non-farming households other than labouring households in the sample suggesting a low incidence overall of non-farm activities, even though the secondary occupations are more diverse. There have also been few changes in occupation among all earners since the Project: only 8 per cent have changed jobs in the Project area and 5 per cent in the control area over the same period.

Table 10.2 Employment characteristics of Sample Households, Kurigram South

Characteristic	Farmer		Labourer		Fishermen		Others	
	Imp.	Cont.	Imp.	Cont.	Imp.	Cont.	Imp.	Cont.
Number Earners per HH	1.55	1.67	1.29	1.38	1.53	1.60	1.43	1.93
% Heads with 2nd occ	61	25	46	12	13	7	43	33
% HH with other main income than heads	3	5	13	6	17	21	20	17
% earners with 2nd occ	43	18	34	9	13	25	45	31

Source: PIE Surveys

10.3.2 Employment

Although construction of the Project, and subsequent periodic repairs and rehabilitation and protection works must have created temporary employment for many labourers, relatively few (about 14 per cent) of sample households reported obtaining work on Project construction (most of which took place over 10 years before the survey).

Although the PIE showed that people regard fishermen and boatmen as having disbenefited, presumably losing income and/or employment, the magnitude of this loss is not known. However, the losses may not have been as large as in some other projects since the Project is surrounded by major rivers on three sides and does not contain very large beels or rivers within its boundary. Hence in the community surveys few villages reported the presence of professional boatmen and only one had apparently given up his occupation since the embankment. Likewise fishermen may have been able to continue and are still obvious where embankment breaches and cuts offer good fishing opportunities because fish are concentrated there, although the amount of floodplain and water connected with the main rivers has doubtless fallen (Chapter 7).

The impact of the Project on agricultural employment appears to have been positive but its magnitude is unclear. Based on the agricultural data from the PIE, for the average cropping pattern per ha. employment is 301 person days per year in the protected area, 338 days in the unprotected impacted area, and 223 days in the control area (respectively 122, 137 and 90 person days per acre per year). This implies that there are about 78 more person days of work per ha. a year in the Project area than there would be with the control area cropping pattern. Also in both areas roughly 50 per cent of agricultural work goes to hired labourers and the rest to family members. However, from the household data of labouring households (Table 10.3) there is very little difference in the average number of days employment per month (only one day more per month in the Project area).

The data come from two separate calculations, but if they are consistent imply that there are about three labourers per cultivated hectare. Moreover wage rates are very low in general and are slightly lower in the Project than in the control area. Hence the evidence suggests that this is very much a labour surplus area, and that while the Project has achieved something in increasing work available in agriculture this benefit is widely scattered as a small gain per household for the many labouring households.

Table 10.3 Level of Employment and Wage Rates of Agricultural Labour Household Heads by month, 1990-1991, Kurigram South

Months	Days employed				Mean Wage rate (Tk/day)	
	Impacted		Control		Inside	Control
	Mean	% days project	Mean	% days project		
Baishakh	21	96	-	-	20	24
Jaistha	21	81	22	0	21	24
Asar	20	85	20	0	20	23
Sravan	20	84	21	0	20	23
Bhadra	17	80	14	0	19	22
Aswin	9	81	9	0	17	20
Kartik	10	86	9	0	17	20
Agrahayan	23	81	23	0	20	24
Poush	22	80	23	0	21	25
Magh	18	85	21	0	20	26
Falgoon	18	84	21	0	20	24
Chaitra	18	83	20	0	19	24
Mean	18	84	17	0	20	23
Total	217		204			

Source : PIE Survey

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The seasonal pattern of agricultural labouring does not appear to differ between Project and control areas. However, there do appear to be some changes in the pattern of migration for work outside the immediate area. The number of households reporting migrating has increased more in the Project area over the 10 years or more since Project completion than from the control area over the same period (increase from 10 to 40 per cent of non-cultivating households in the impacted area, but from 21 to 33 per cent in the control area), again suggesting a limited employment gain. Also fewer labourers now migrate for the Boro season than in the past (reflecting the growth of small scale irrigation in the Project area), whereas the seasons for migration appear unchanged among migrating households in the control area. By comparison the situation for non-agricultural labour may not have changed much - the slack period has remained the monsoon months in the Project area. Non-agricultural labour appears to be less important for labouring households in the control area.

The evidence from the PIE survey on migration is in contradiction with the impression gained from the RRA which reported an improvement in wage labour opportunities and hence a reduction in migration to neighbouring Districts of up to 50 per cent since the Project. However, the RRA result was unclear since many labourers were still found to migrate for harvest work outside the area, but some in-migration at harvest times inside the Project was also reported.

10.4 INCOMES

10.4.1 Introduction

The PIE survey provided an opportunity to compute household incomes and to investigate the distributional differences between Project and control areas and hence the potential distributional impacts of the Project. However, it is important to recognise the limitations of this analysis.

It is not known whether Project and control areas differed in their income distributions before the Project. Although to the extent that water regimes and cropping patterns were similar at that time it is hoped that there would have been similar agriculture related income levels; differences in land tenure, holding sizes and non-farm employment opportunities could still have meant that income distributions differed. In fact data on landholdings and changes in these since the Project suggest that among farmers/landowners the distribution of households by holding size has differed between Project and control areas since before the Project (specifically a higher percentage of households are in the 21-100 decimal category in the Project while a higher percentage are in the 251-750 decimal category in the control area, so this may be influencing the income calculations. Also the incomes are based on the reported agricultural outputs in the year 1990-91 which may not be typical (although 1990 appeared to be a normal monsoon - damaging flooding occurred during the PIE surveys in 1991 but calculations do not include the damaged crops). Likewise the calculations for farmers depend on reported agricultural inputs and their costs, which are subject to a considerable risk of distortion due to a lengthy recall period. Other income sources are based on the incomes reported in direct questioning and again will be approximate figures because of recall problems, with the exception of livestock (where costs of production have been subtracted) they do not take account of any costs incurred.

10.4.2 Income levels and inequality

With these qualifications, Table 10.4 shows that per capita incomes are 11 per cent higher in the Project impacted area compared with the control area, but that household incomes are fractionally lower (by 3 per cent) in the impacted area; the difference results from the smaller family sizes found in the Project impacted area. Hence overall the Project appears to have had a small positive income effect, but this is not evenly distributed and is possibly biased by the differences in landholding sizes found between Project and control areas. For individual landholding categories the 'gain' in the Project compared with the control area is generally greater than the average difference both for small and large landholding categories, thus households with up to 20 decimals have per capita incomes 24 per cent higher inside the Project than in the control area, and in the two largest landholding categories project incomes are 29-52 per cent higher.

Table 10.4 Household Income by Landholding Category Kurigram South (Tk in 1990-91)

Landholding	Impacted				Control			
	No. hh	Tk/hh	Tk/person	Tk/earner	No. hh	Tk/hh	Tk/person	Tk/earner
≤ 20d	51	8851	1873	6542	25	8137	1507	6164
21-100d	42	17872	3443	14719	9	11285	1916	7813
101-250d	48	29256	4793	19504	24	23103	3672	14592
251-500d	19	43721	6020	21860	14	41081	5584	23964
501-750d	5	72066	7507	32757	8	54753	5840	20858
+750d	3	111812	10820	41929	4	64150	7128	51319
All hh	168	24600	4265	16598	84	25348	3850	15890

Source : PIE Survey

Incomes are unevenly distributed in both Project and control areas, and this correlates with landholding size, however the inequality is comparable in both areas, for example the largest landholding category has a per capita income level 5.8 times that of the smallest landholders in the impacted area, and in the control area the same differential is 4.7 times.

The original sample was drawn for cultivating and non-cultivating households. Table 10.5 shows that there are small differences in average per capita income between Project and control areas for both types of household, and that the Project does not appear to have widened the income gap between farming and non-farming households. While there appears to be a consistent difference which may reflect higher agricultural production and increased employment in the Project, this should not be stressed unduly since there is very little difference in household incomes - the difference arises because earners have higher incomes in the Project area.

Table 10.5 Incomes of Farming and Non-farming households

	Farming		Non-farming	
	Impacted	Control	Impacted	Control
No households	120	60	48	24
Members/hh	6.2	7.0	4.8	5.5
Mean Income				
Tk/hh	31137	32155	8257	8330
Tk/person	5042	4572	1738	1526
Impacted as % of control				
	+10%		+14%	
Farmers as multiple of non-farmers				
	2.9	3.0		

Source: PIE Surveys

10.4.3 Sources of Income

Both the Project and control areas are heavily dependent on agriculture, however households in both areas often have several sources of income as shown by Table 10.6. While the overall pattern reflects the size of sample of farm and non-farming households, the differences between landholding categories are relevant to the comparison. There are generally few project-control differences in the relative sources of income. Different categories of household in the Project area in general seem to have more diverse income sources - for example the smallest land category are less dependent on wage labour. Crafts appear to be particularly important for the marginal farmers, but are also relatively more important in the Project area. This is also the case for salaries - proximity to the District and Upazila towns is better in the Project area. As a consequence medium to large landowners in the control area appear to be more dependent on agriculture than in the control area, and it may be that part of the difference in relative incomes between Project and control areas reflects the different importance of non-farm income sources which is unlikely to be a Project impact.

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Table 10.6 Source of Household Income by Landholding Class, Kurigram South

a) Impacted area

Landholding	No. hh	Percentage of income from										
		Cultivation	Trees	Homestead	Livestock	Salaries	Business	Rents	Crafts	Fishing	Transport	Wage labour
< 20d	51	8	9	3	2	4	0	0	9	4	2	60
21-100d	42	45	8	2	5	6	0	1	17	4	0	10
101-250d	48	54	9	1	2	17	2	4	10	2	0	1
251-500d	19	69	7	1	4	7	7	3	2	1	0	0
501-750d	5	87	7	1	-2	0	0	3	4	1	0	0
+750d	5	63	9	0	3	10	0	13	1	1	0	0
All hh	168	54	8	2	3	9	2	3	8	2	0	9

b) Control area

Landholding	No. hh	Percentage of income from:										
		Cultivation	Trees	Homestead	Livestock	Salaries	Business	Rents	Crafts	Fishing	Transport	Wage labour
< 20d	25	2	10	3	1	7	0	0	2	3	1	71
21-100d	9	32	11	4	5	0	0	1	21	2	0	24
101-250d	24	67	11	2	3	9	0	2	1	2	0	3
251-500d	14	75	5	2	0	8	0	6	3	2	0	0
501-750d	8	83	12	1	-1	0	0	4	0	1	0	0
+750d	4	82	6	1	4	0	0	4	1	3	0	0
All hh	84	66	9	2	1	5	0	3	2	2	0	9

Source : PIE Survey

10.5 LAND HOLDINGS AND LAND ACQUISITION

10.5.1 Land Holding Changes

Because Kurigram South Project has been completed for a longer period (over 10 years) than some of the other PIE projects, more households might be expected to have changed landholding size just through the passage of time. However, this does not appear to be the case - if anything slightly fewer households have gained or lost land. Table 10.7 shows little difference in the incidence of changes in holding between Project and control areas (the impacted unprotected areas are in the active floodplain and include char areas so more decreases in holding were to be expected). Any difference in landholding category mobility (movements between the landholding categories used in Section 10.4) since the Project between Project and control areas has been small: 3 per cent rose and 6 per cent fell a landholding category in the Project compared with 6 per cent rising and 5 per cent falling in the control area. The Project does not appear to have reduced the trend of declining holding sizes. Table 10.8 shows that land transactions in the control area have been more concentrated in the period since 1987 than in the Project area, the reasons are not clear but it may be that there are more land transactions after flood damages occur.

Table 10.7 Changes in Landholding since the Project, Kurigram South

Change	Impacted		Control
	Protected	Unprotected	
Increase	21 (14.13)	2 (9.5)	12 (14.3)
No change	100 (68.0)	14 (66.7)	61 (72.6)
Decrease	26 (17.7)	5 (23.8)	11 (13.1)
Total	147 (58.3)	21 (8.3)	84 (33.3)

Source : PIE Survey

Table 10.8 Amount of Land Purchased and Sold (dec) since the Project, Kurigram South

Year	Protected		Impacted, unprotected		Control	
	purchased	sold	purchased	sold	purchased	Sold
1983	0	16	0	0	33	0
1984	121	0	0	0	0	0
1985	0	133	0	6	0	0
1986	367	170	0	0	4	14
1987	248	157	0	0	84	105
1988	198	225	0	40	249	147
1989	104	275	95	0	121	149
1990	149	136	0	38	148	54
1991	253	24	44	0	0	16

Source : PIE Survey

The pattern of land price changes reported at the village level in Table 10.9 suggests that there have been some productivity changes related to the Project which the land market may have recognised. Non-irrigated land prices in the Project have increased by a greater percentage than in the control area, which could be associated with flood protection. However, irrigated land prices have risen much faster in the control area than in the Project over the same period - this might reflect the introduction of irrigation rather than changes in value of land irrigated before the Project was completed. It would also appear that land values were higher in the Project area than in the control even in pre-Project times which implies that agriculture was more productive there before the Project and hence that project-control differences may not be due to the Project alone.

Table 10.9 Land Prices Kurigram (Tk./dec)

Irrigation status/period	Protected			Unprotected			Control		
Irrigated	H	M	L	H	M	L	H	M	L
Pre-project	402	361	316	100	150	150	100	150	150
Post-project	721	711	591	300	500	350	300	500	350
% Change	+79	+97	+87	+200	+233	+133	+200	+233	+133
Non-Irrigated									
Pre-project	300	309	257	233	175	87	233	175	87
Post-project	600	619	475	400	333	125	400	333	125
% Change	+100	+100	+85	+72	+90	+44	+72	+90	+44

Note: H - High land, M - Medium level land, L - Low level land
Pre-project = pre-1980, Post-project = mid-1991

Source : Mouza Survey

10.5.2 Land Acquisition

A very low percentage of households were found to have lost land to Project construction (Table 10.10), with only 7 (4 per cent) of households affected although these on average lost almost half an acre (0.19 ha). This may be because the Project is very large and so the proportion of land lost to the embankment was small, also there has been virtually no excavation of channels within the Project.

Although the proportion of households affected may be low, the absolute number for 110 km of embankment will have been high and Table 10.11 shows by far the poorest record for payment of compensation found in the five PIE study projects. None of the respondents reported receiving compensation without paying a bribe, but in seven cases, covering 53 per cent of the land acquired from surveyed households (admittedly a small sample) people have never received compensation after more than ten years. Obviously this results in considerable resentment about the project. This survey data confirms the widespread finding from the RRA that people had not been compensated, or only inadequately and after a long delay if they received anything. Moreover those who have not been paid compensation continue to pay land tax for land which is now under the embankment.

Table 10.10 Incidence of Land Acquisition, Kurigram South

Category	Land Type		Total
	Homestead	Agricultural	
No. of households	1	6	7
% of household affected	0.6%	4%	4%
Total area acquired (dec.)	15	305	320
Mean per HH with land acquired (dec.)	15	51	46

Source : PIE Survey

Table 10.11 Payment of Compensation for Acquired Land, Kurigram South

Category	No. of Cases	Mean Area (dec) of the plots acquired	Total Area Acquired (dec)	Mean Taka/dec compensated	Mean months for compensation	Mean Bribe Tk/dec
Not compensated	5	28	140	0		
Compensated no bribe			0			
Compensated after bribe	4	45	180	104	21	9
Bribe paid but no compensation	2	30	60	-	-	12
All cases	11	35	380	49	-	6

Source : PIE Survey

10.6 INVESTMENT AND QUALITY OF LIFE

10.6.1 Quality of Life

The construction and quality of housing are indicators of any ultimate benefit of FCD/I projects since households may invest in improved houses if they receive increased incomes because of a project. However, Table 10.12 shows no difference between housing stock in Project and control areas - in both there are hardly any pucca or semi-pucca houses, most being of thatch, also if anything the condition of houses is better in the control area. Either households have invested elsewhere or have not gained enough to improve their housing. However, Table 10.12 does show that people living in the unprotected impacted area face greater housing problems - the condition of their houses is worse and more have had to carry out major repairs reflecting the greater risk of flooding in the active floodplain. It is not known whether the incidence and severity of flooding has become worse since the Project for these people (although public opinion is that they have been adversely affected).

Access to tubewells for drinking water has improved rather more in the Project than in the control area (up 27 per cent to 94 per cent of households in the Project, and up 15 per cent to 89 per cent in the control area), and 43 per cent of farming households own a HTW/MOSTI compared with 27 per cent in the control area. This may be a Project related benefit. Otherwise sanitary conditions are no better in the Project area, and asset ownership does not appear to differ between the two areas.

Table 10.12 Percentage of Households with Different House Types, Kurigram South

Construction Type (Main Room)	Impacted		
	Protected	Unprotected	Control
All Pucca	1	0	2
Pucca wall	4	0	4
C.I wall and roof	4	5	4
Earth wall/tile roof	1	0	1
Thatched wall tile roof	33	28	33
Thatched wall and roof	58	67	56
Condition of Main House			
Good	16	0	25
Fair	44	48	27
Bad	41	52	48
Invested in New Construction since Project			
Major Repair	53	76	46
New Room	15	10	21
Both	1	0	0
None	31	14	32

Source : PIE Survey

From the main household survey both Project and control areas have less food intake than other PIE areas, and the seasonal pattern of food availability and intake does not appear to differ between the two areas (Figure 10.1). However, conditions appear to be worse in the control area where a few households report starving in the lean period of the monsoon, and where fewer households are well fed in the peak periods. Hence it would appear that food consumption is better in general in the Project area, although this may partly reflect changes in irrigation which are not due to the Project.

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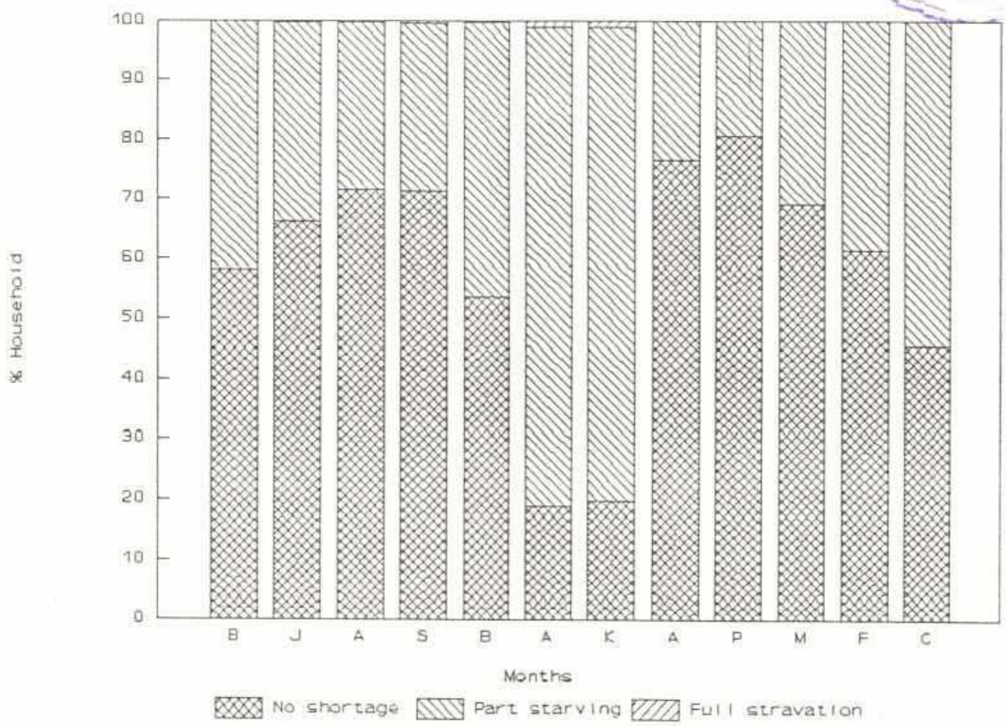
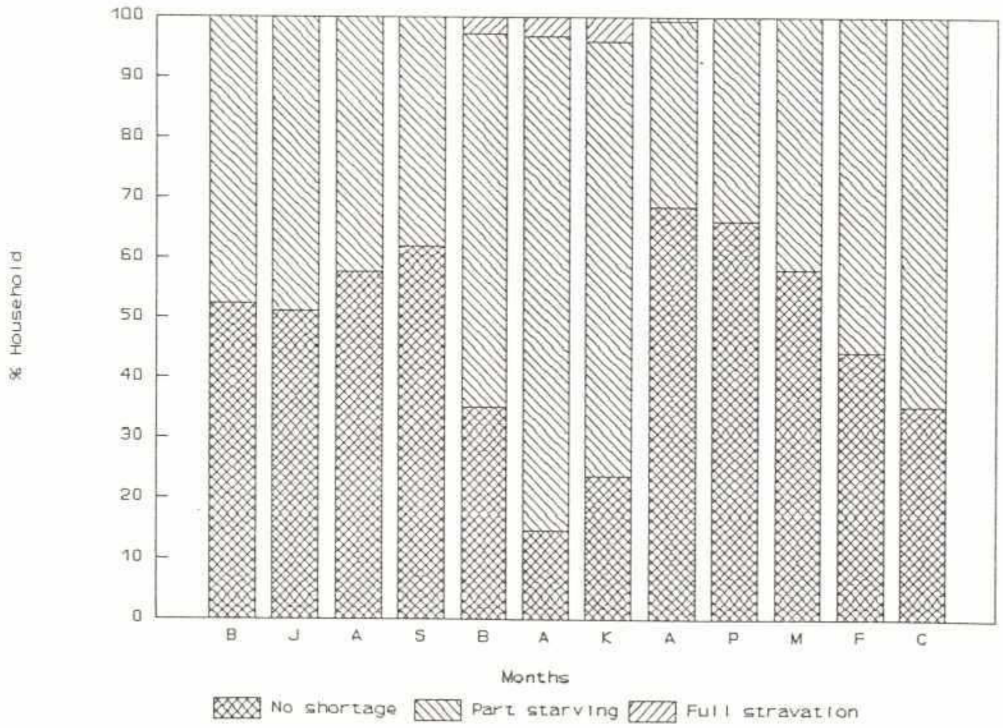
Figure 10.1 Monthly Pattern of Food Consumption
Impacted Protected Area, Kurigram South



Control Area, Kurigram South



10.6.2 Credit

Credit appears to be more concentrated in the control area compared with the Project (Table 10.13). In general there does not appear to be more uptake of credit to cover input costs which might have been expected if the Project increases the use of HYVs and purchased inputs, nor does the need for credit to cover necessities appear to have fallen. Presumably also the availability of credit is no better inside the Project, suggesting a lack of secondary institutional developments.

Table 10.13 Credit Use During 1990-91, Kurigram South

	Protected		Unprotected		Control	
	Farmer	Non-cultivator	Farmer	Non-cultivator	Farmer	Non-cultivator
No. hh	105	42	15	6	60	24
No. hh receiving loan	43	22	7	4	29	15
Mean loan (Tk) (overall hh)	2780	1317	580	541	3661	806
Percentage use of loans						
Cultivation	15	0	0	0	30	0
Livestock	2	0	0	0	0	0
House repair	0	8	0	0	0	0
Necessities	75	86	100	100	67	93
Social function	7	4	0	0	3	7

Source : PIE Survey

10.7 RECENT FLOOD EXPERIENCE

10.7.1 Incidence of Flooding

The relative incidence of unusual floods between Project and control areas is not clear. In the control area there was flooding in 1987 and 1988 (see Section 10.7.2) from rivers originating in India, but it does not appear to have been as prone to unusual floods as the Project area before the embankment was built. In the Project area 62 per cent of villages surveyed reported that before the project they experienced flooding every year, while in two (9 per cent) it was rare. It would not appear that the Project has had much success in reducing the flood risk since 91 per cent of villages reported experiencing a flood since Project completion with a mean of 2.4 years with floods (although this compares with four flood years since the Project in the impacted unprotected area). In fact a large part of the Project area was affected by flooding in September 1991 at the time of the interview surveys.

10.7.2 Crop Damage

In both 1987 and 1988 the extent of crop damage from flooding appears to have been much higher in the control area than in the Project (Table 10.14). The control area appeared to be the most badly affected area surveyed in the PIEs in terms of crop damage. Hence when both Aus and Aman crops were badly damaged in the control area (ranging from one third of normal yields to completely destroyed), inside the Project yields were 50-75 per cent of normal. However, these are averages and may be biased by the Project area having rather more high land than is found in the control area. Even so the Project would appear to have been relatively successful in these years in reducing potential crop damage.

Table 10.14 Percentage of Normal Yield Achieved in 1987 and 1988 Flood Years, Kurigram

Crops/ Project	1987			1988		
	Prot.	Unprot.	Control	Prot.	Unprot.	Control
B. Aman	73	75	0	76	75	0
L.T. Aman	62	27	20	70	26	20
HYV Aman	58	0	11	60	-	8
B. Aus	59	25	18	56	17	33
HYV Aus	51	-	0	52	-	0
Jute	53	25	14	49	17	14

Source: Mouza surveys

10.7.3 Non-crop Damage

Table 10.15 shows that rather paradoxically, given the high crop damage, fewer homesteads were affected by flooding in 1988 in the control area (24 per cent) than inside the Project (46 per cent). However, the unprotected impacted area was much more badly affected (86 per cent of households). It is also notable that flood peaks are relatively short (about a week), and that relatively few of the households were affected in 1991 (but an unknown number were interviewed before the flood peak that year). Damages appeared to be higher in 1988 than in subsequent years, but did not differ between protected and control areas. Average financial loss per household was low reflecting flooding of moderate severity (shorter than in other PIE locations) and the low quality of housing in the area, the value of damages for thatch houses did not appear to vary with depth of flooding in the range up to 1 m.

Overall the Project probably does provide greater security from flood damages, but this is not uniform throughout the area because of erosion and breaching of the embankment and flows of water into the Project overland from the west. The embankment also provides a place of refuge for some households, although for most it is far away and local high land and roads are more important refuges.

Table 10.15 Recent Floods, Kurigram South

a) Characteristics of last flood of homestead

Flood year	Characteristics	Protected	Unprotected	Control
1988	No. of hh flooded	68	18	20
	Mean depth (ft.)	1.8	2.0	1.6
	Mean duration (days)	9	7	6
1989	No. of hh flooded	0	0	1
	Mean depth (ft.)			1.0
	Mean duration (days)			4
1990	No. of hh flooded	4	0	4
	Mean depth (ft.)	1.0		1.0
	Mean duration (days)	4		6
1991	No. of hh flooded	6	3	5
	Mean depth (ft.)	2.3	2.7	2.0
	Mean duration (days)	4	5	4

(b) Non farm (non-crop) flood losses (mean Tk/household current prices) in last damaging flood, Kurigram South

Year		Protected		Unprotected		Control	
		Affected	Damaged	Affected	Damaged	Affected	Damaged
1988	No. of hh	68	56	18	16	20	16
	Tk/hh	771	937	427	481	777	972
1989	No. of hh	-	-	-	-	1	1
	Tk/hh	-	-	-	-	600	600
1990	No. of hh	4	1	-	-	4	2
	Tk/hh	150	600	-	-	250	500
1991	No. of hh	6	3	3	1	5	2
	Tk/hh	150	300	67	200	200	500

Source: PIE Survey

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10.8 LOCAL PARTICIPATION, OPINIONS AND SOCIAL CONFLICTS

10.8.1 Public participation

Public participation has been poor in this Project. Problems over land acquisition have already been noted and the failure to pay compensation has obviously created considerable resentment of the Project among those who lost land. Moreover local people dispute the alignment of the embankment in places arguing that it has cut across local drainage systems resulting in problems for people inside and outside the embankment. This implies that an opportunity to improve the detailed project planning by consulting local people was lost and instead resentment over the Project was encouraged. Over 40 per cent of households reported having doubts about the Project during its implementation period (Table 10.16), although very few reported taking actions to prevent its construction. At the village level dissatisfaction and feuds were reported over the Project in 29 per cent of mouzas. Construction did provide employment on earthworks but the proportion of households obtaining work in this way appeared to be relatively low (although it was presumably higher in villages close to the embankment).

Table 10.16 Conflicts over Project Implementation, Kurigram South

Whether households doubted usefulness of project and measures taken	Protected		Unprotected	
	Farmer	Non-cultivator	Farmer	Non-cultivator
% of all households with doubts about project	40%	43%	40%	50%
No. of households with doubts	42	18	6	3
% doubting households attempting to prevent project	3%		22%	
Measures taken (no. households)				
Petitioned BWDB			1	
Protested to local admin.			1	
Used force			1	
Other action	2			

Source : PIE Survey

An important aspect of the Project is the shelter which the embankment provides to people from outside the Project who lose land to erosion by the rivers, or whose homes are flooded in the outside char areas. There is housing along one side, and in some places both sides, of the embankment for virtually all its length. For much of its length this is virtually a linear village, although in some areas the density is lower. Clearly this is an unintended benefit from the Project as it permits people to occupy land which is safe from flooding, free of charge, and to remain close to their cultivable land if any remains, or until land reappears from the river.

However, housing on the embankment is technically illegal (although in practice it would be impossible to prevent people from settling there), and it does cause damage to the embankment (see Chapters 2 and 4). There is a need to incorporate this social benefit into the planning of embankments along major rivers which are eroding the riverside near the projects. Additionally a problem arises in places such as Chilmari where the embankment is being eroded and with it the homes of people who had moved onto the embankment, it appears that people are moving from this immediate risk into locations which in the longer term are equally dangerous such as relatively low land within the Project which is not traditionally under homesteads and which will be threatened by flooding if there is a breach.

10.8.2 Opinions regarding the Project

A high percentage (71 per cent) of households reported that the Project was successful in protecting crops from floods, the other major benefits reported were better communications (65 per cent), protection of homesteads from flooding (40 per cent) and the potential to grow an additional crop (26 per cent). Few households in the unprotected impacted area reported any benefit other than improved communications (29 per cent). Concerning communications the RRA found that the Project had protected physical infrastructure such as roads (and the embankment is used as a village road), as a consequence this has facilitated marketing and development activities of government and NGOs alike. The process is complex since many earth roads have also been built since the Project and probably would have been built without it. However, officials of RDRS, Proshika, Chhinna Mukul and Grameen Bank reported that the Project had facilitated their development activities by making access easier to previously remote areas.

There are also a wide range of problems and disbenefits which people reported due to the Project. 40 per cent of people reported damage to the embankment to be a problem (reflecting the serious erosion problems), 37 per cent reported loss of open-water fish, 28 per cent waterlogging (the lowest percentage among the PIE projects), and 26 per cent a decline in soil fertility. In the unprotected impacted area the problems are rather different: land erosion (33 per cent), damage to houses (29 per cent) and public cuts (29 per cent). Although the evaluation did not prove adverse effects from the Project this is widely believed to have happened by people living inside the Project (39 per cent said outsiders had disbenefited). The other group regarded as having disbenefited were fishermen (30 per cent said they were disbenefited). It was generally agreed that large landowners had benefited most, and that after this group labourers and farmers in general had benefited.

Overall the opinions of respondents, the data they provided, and the RRAs give a similar picture: of moderate benefits but an area which is still poor relative to other regions. A more integrated development programme, along with more effective flood protection, might be needed if the area is to become more prosperous. A formal means of directing some benefits to those outside the Project (particularly on river chars) is needed, probably involving planned homesteads and other uses of the embankment. Otherwise this important minority are not benefited and may even be made worse off by the Project.

11. ENVIRONMENTAL EVALUATION

11.1 PRE-PROJECT SITUATION

Kurigram FCD/I Project (South Unit) was completed in 1983, following a protracted ten-year period of construction. Most of the planned drainage re-excavation was carried out under the Zia (i.e. Voluntary) programme but is still to be considered as part of the Project. The surface irrigation component was omitted altogether and is currently the subject of yet another feasibility study (BWDB 1987a). 1991, therefore, was the Project's eighth monsoon season. The Project Area has a substantial network of motorable roads which has facilitated agricultural development; however, the roads are not part of the FCD/I Project and their impacts are excluded from the environmental evaluation.

The FAO (1988) agroecological maps and reports, which cover the whole of Bangladesh, provide a reasonable overview of pre-project environmental conditions, as they are based largely on soil surveys carried out mainly between 1965 and 1977. In the Kurigram area, the relevant soil survey took place in 1970. Other pre-Project information and trends were obtained through discussions and in-depth interviews with local people during the RRA and environmental field visits in March and November, 1991, and from the sources noted in section 11.3.6.

Kurigram South is one of the largest and agroecologically most diverse of the 17 FAP 12 projects. FAO (1988) shows it to consist largely of a single agroecological region (AER): the Teesta Meander Floodplain (TMFP). In a number of places, however, poor engineering planning and design have located the embankment within the active meander floodplains of the Teesta, Dharla and Brahmaputra Rivers. As a result, about 8 per cent of the Project Area comprises several separate tracts of FAO's Active Teesta Floodplain AER.

Within the Teesta Meander Floodplain AER, FAO have defined a number of agroecological subregions (AES), of which two occur in Kurigram South: the Central and Eastern TMFPs. Table 11.1 summarises the FAO classification within the Project Area, including the nine soil associations mapped by FAO.

The FAO agroecological classification, therefore, provides a broad spatial framework for environmental assessment both before and after the FCD/I Project, especially when related to the pre-project flood depths given in Table 11.1. As mapped by FAO at a scale of 1:750,000, however, the framework is inevitably imprecise for assessment purposes. One of the chief aims of the environmental fieldwork was to establish agroecological divisions (AED) derived from the FAO classification but creating units which relate directly to pre-project (and post-project) environmental conditions (Table 11.1). The FAO mapping was then refined to delineate the AEDs at the FAP 12 map scale, here of 1:150,000 scale (Figure 11.1).

Six AEDs have been defined and are illustrated schematically in Figure 11.2. Pre-project conditions in each are discussed below:

AED A: Kurigram Ridge

AED A extends westwards from just beyond Kurigram town, covering about 6 per cent (3,900 ha) of the Project Area. It consists mainly of Highland, with some Medium Highland,

Table 11.1 Kurigram South: Agroecological Classification

Agroecological Region (FAO)	TEESTA MEANDER FLOODPLAIN							ACTIVE TEESTA FLOODPLAIN	
Agroecological Subregion (FAO)	CENTRAL TMFP					EASTERN TMFP		-	
Soil Association (FAO)	Tm 149	Tm 154	Tm 151	Tm 163	Tm 172*	Tm 162	Tm 176	Ta 147	Ta 148
(Approx. % of Area)	(4)	(2)	(6.5)	(6)	(2.5)	(66)	(5)	(3)	(5)
Land Types (Flooding - cm)									
Settlements	9	12	10	11	5	10	6	2	5
H (0)	67	53	62	37	2	17	2	0	10
MH1 (0-30)	17	15	7.5	31	13.5	12.5	5	13	15
MH2 (30-90)	7	20	19.5	20	57.5	54.5	55	85	70
ML (90-180)	0	0	1	1	22	6	32	0	0
L (180-300)	0	0	0	0	0	0	0	0	0
VL (300+)	0	0	0	0	0	0	0	0	0
Total	100	100	100	100	100	100	100	100	100
Agroecological Divisions (FAP 12)	A		B		Bo	C D	E	R	
Approx. % of Area	6		15		(2.5)	37 29	5	8	

* Tm 172 forms a distinctive subdivision (Bo) within AED B (see text).

Source: FAO (1988) and FAP 12.

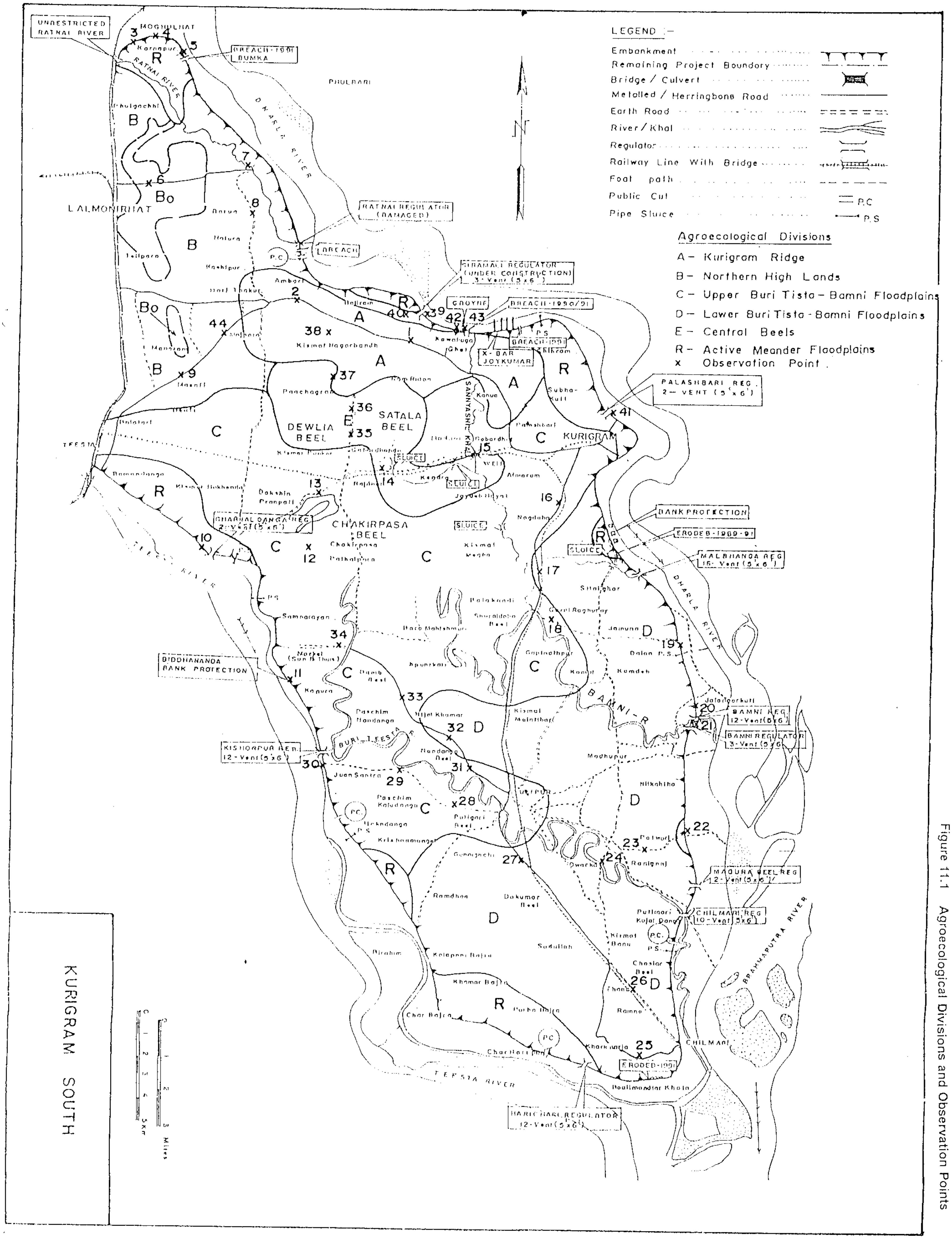
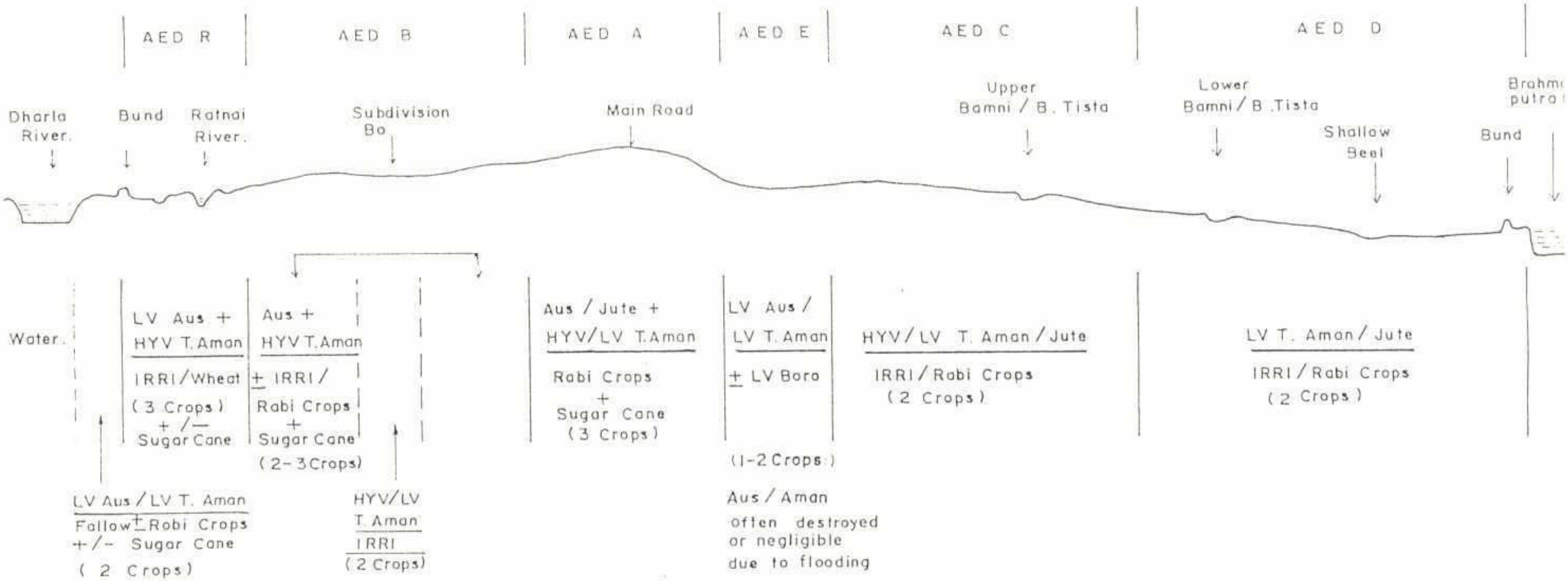


Figure 11.1 Agroecological Divisions and Observation Points

Figure 11.2 Kurigram South: Agroecological Divisions (AED)



NOTE .—
All AEDs except AED E and Subdivision Bo, but including the riverine external AEDs, have villages with fruit trees and ponds on their higher lands. Setteement is especially dense in AED A.

forming a smooth ridge. Flooding in pre-project times was restricted largely to the peripheral lower slopes of the ridge and even there was of limited depth and duration. The land was above most river floods and rainfall either ran off the high land or percolated rapidly into the very permeable soils. Only a thin surface horizon of silty soil overlies the dominantly sandy subsoil and substratum in this area.

Pre-project agriculture consisted mainly of Aus paddy or jute, followed by local T. Aman, with a wide range of rabi crops (wheat, mustard, brinjal, chillies, potatoes, pulses, millet); sugar cane was also grown. Irrigation was largely limited to the manual treadle-pump methods, so that the droughty nature of the soils was a severe constraint to crop productivity.

The ridge was the logical location for major transport routes and settlement concentrations, with the latter as usual accompanied by trees (including fruits such as bananas and dates) and ponds for washing, fishing and sometimes drinking.

AED B: Northern High Lands

To the west and north, AED A is surrounded by land of more varied relief, comprising a series of ill-defined low ridges and small, very shallow basins. As Table 11.1 shows, there is still considerable Highland, but with Medium Highland dominant. Within AED B there are also two mappable extents of well-defined, near-level basins which form a distinctive unit. It is too small to separate out as another AED and so is included as an agroecological, subdivision of AED B, Subdivision Bo. AED B accounts for 15 per cent of the FCD/I Project Area (9,750 ha), of which Subdivision Bo comprises 2.5 per cent (1,600 ha).

Pre-project flooding was slight to moderate, generally able to run off to the south or to percolate into the still predominantly sandy soils, although the silty topsoil here is somewhat thicker than in AED A. Flooding came from the Dharla and Ratnai Rivers to the north-east and from the Tista on the west.

Land use reflected the topography, with villages, trees, ponds and roads following the low ridges, but forming a correspondingly ill-defined pattern surrounding small to medium basins in which not only paddy but also sugar cane was grown. LV Aus was followed by LV T. Aman paddy, with a similar range of rabi crops to AED A. As in AED A, therefore, three crops per year were often attempted, although Aman suffered at times from either floods or drought. Again, droughty soils were a constraint on rabi cropping, given the limited irrigation development.

Subdivision Bo, despite its lower levels and deeper flooding, seems to have attained a remarkable equilibrium in which flooding in most years allowed successful Aus and Aman cultivation without significant damage. As a result, the distinctive, large, flattish basins were wholly occupied by paddy fields, except for occasional very small beels patches.

AEDs C and D: Buri Teesta-Bamni Floodplains

The southern two-thirds of the Project Area have been formed mainly by alluvial sedimentation from past and present Teesta courses. Many old course remnants are detectable throughout this area but the two most recent and distinctive are the Buri Teesta and the probably slightly older Bamni Rivers. Pre-project, these dead rivers were probably only seasonal, conveying rainfall run-off to the main rivers, when possible, and drying up along much of their lengths by the late rabi season.

In pre-project times it would probably not have been justified to separate AEDs C and D. Together they comprise FAO's soil association Tm 162 (Table 11.1) and form part of the lower, flatter Eastern Teesta Meander Floodplain AES. They cover 66 per cent of the Project Area (about 43,000 ha).

Soils here have a substantial thickness of silty topsoil and subsoil, with sandier substrata. Table 11.1 shows relief to consist mainly of MH2 land type, implying moderate flooding. This accords with the view of the Feasibility Report (Techno Consult Eastern Ltd, 1975) that the Dharla River usually flooded mainly on its left bank, while the Teesta flooded regularly only along its lower left-bank reaches. Much of the flooding in AEDs C and D in fact resulted from rainfall and run-off from the much higher land to the north (Figure 11.2).

The topographic patterns and consequent pre-project land use patterns were better defined than in AED B, with flat-bottomed paddy basins surrounded by low ridges where settlement and its related land uses were concentrated. In general, the paddy basins increased in size in a south-east direction. Beyond Ulipur, the paddy basins dominated the landscape. Thus AED C comprised medium to small basins, with a corresponding higher proportion of ridges, while AED D had large to medium basins and fewer ridges. Superimposed upon this local ridge-and-basin pattern were the two meander belts of the Buri Teesta and Bamni Rivers, with their slight levees and flanking backswamps, where small, seasonal, shallow beels formed. Capture fishing was locally important in the meander pools and backswamp beels, although less so than in the other PIE areas.

The division between AEDs C and D is obviously a somewhat arbitrary one. As mapped, AED C is the more extensive covering 37 per cent of the Project Area (some 24,000 ha.), with AED D accounting for 29 per cent (about 19,000 ha.).

Pre-project cultivation was much the same throughout AEDs C and D, with local Aus or jute followed by local Aman. Rabi crops were mostly limited to the ridges and basin rims.

AED E: Central Beels

The least fortunate part of the Project Area occurs immediately south of the Kurigram Ridge. Surrounded by much higher land which has extremely permeable soils, the area receives both rapid run-off and rapid percolation. The resulting floods following monsoon rains accumulate on the near-level relief to form what in pre-project monsoon times is said to have been a more or less continuous beel, generally referred to as Dewlia Beel. This was shallow and reduced to a series of small perennial patches during the rabi season, represented today by separate beels such as Dewlia, Sarala and Bogila Beels.

Pre-project land use consisted mainly of local Aus and Aman on the fringes of the beel, with local Boro possible in places on the receding water. Settlements were restricted to the adjoining higher lands in AEDs B and A. AED E covers only 5 per cent of the Project Area (3,250 ha).

AED R: Active Meander Floodplains

About 8 per cent of the Project Area (5,200 ha) consists of the active meander floodplains of the Teesta and Dharla Rivers, with even a small tract of Brahmaputra (Jamuna) active meander floodplain in the south east. Given the size and strength of these rivers and the wholly unsatisfactory nature of the sandy alluvium of the active meander floodplain for

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bund construction, it would seem that the engineering planners and designers can only have ignored the soil maps and data that were available to them. It is unlikely that in the long term any embankment can be sustained within the active meander floodplains except at exorbitant cost in materials and effort, and even then with a high risk of failure.

Relief within the active meander floodplains is very varied but often consists of chars backed by oxbow channels, usually at levels below the adjacent Teesta Meander Floodplain, making them very vulnerable to breaches.

Land use pre-project in the Dharla and Teesta active meander floodplains within the Project Area was fairly intensive, as it is today in their riverine areas (see Section 11.3.3). Local Aus and Aman were grown, with sugar cane widespread in many parts. In the dry season, the sandy soils were difficult to cultivate for rabi crops except where water was within easy access. The silty topsoils found in the Teesta Meander Floodplain are very thin and discontinuous or absent altogether in AED R.

11.2 PROJECT OBJECTIVES

No account was taken of environmental aspects in the various project preparation documents (Section 11.3), although these included a good deal of useful and relevant information relating to the environment. Project appraisal based on economic analysis largely ignored or dismissed a number of key issues that the holistic perspective of environmental evaluation would have provided. Such issues include: external areas affected by the Project; livestock; fisheries; wetland ecology; river behaviour and ecology.

11.3 APPROACH AND SOURCES OF INFORMATION

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 requires 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 the environmental field observations and interviews are more intensive along carefully selected transects (Figure 11.1). 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). 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 containing itself to the Project Area and any identified external areas (Section 11.3.3) affected by the Project. The PEP also evaluates the environmental impacts of the Project over all the years since 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 PIE 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 agroecological divisions used within the Project Area are the six AEDs defined in Section 11.1, with external (off-site) impact areas defined below in Section 11.3.3. Agroecological divisions are dynamic, changing especially in response to human influence. However, in Kurigram South it is indicative of the limited agroecological impact of the Project that the boundaries of the AEDs defined to illustrate pre-project conditions in Section 11.1 remain the same today. Possibly AEDs C and D might have formed a single AED pre-project, as noted.

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 may be significantly affected by the Project. Project planning for Kurigram South and many similar projects in Bangladesh in the past has paid scant regard to such aspects. The projects originated by the FAP programme clearly must improve on this.

There are three external areas affected by Kurigram South FCD/I Project, all of which include extensive tracts of cultivated land with numerous settlements:

- Teesta Riverine Area (TRA);
- Dharla Riverine Area (DRA);
- Brahmaputra (Jamuna) Riverine Area (BRA), which also incorporates the downstream effects of the Project.

The Teesta Riverine Area flanks the Project Area on the west and comprises the land along the Teesta outside the embankment. Where the river is some distance from the embankment, the land is fairly intensively cultivated with local Aus and Aman paddy and some settlements occur. River fisheries are important, as everywhere in Bangladesh. The land adjacent to the Project is subject to greater flooding and erosion hazards than the Dharla Riverine Area because of the Teesta's tendency to flood on its left bank.

The Dharla Riverine Area is generally more intensively cultivated and settled adjacent to the Project Area, because the Dharla also floods more on its left bank. In addition to two paddy crops, sugar cane is often widespread, with rabi crops where water is accessible. The DRA adjoins the Project Area on the north-east side.

The Brahmaputra Riverine Area occurs to the south east of the Project, with cultivated and settled land along the south-east margin decreasing southwards as setback narrows; but with a number of chars "off-shore" of the embankment which are temporarily or permanently occupied.

11.3.4 Control Area

For the PIE socio-economic surveys a control area in part of the incomplete Kurigram North Project was selected (Chapter 1). This provides a basis for comparison of with- and without-project situations. For reasons discussed in Section 11.3.1, the Control area has not been included in the environmental fieldwork, although the PIE findings are included in the impact assessment for many of the human environmental issues in Section 11.6. The Control area would be of less value for physical and biological assessments because it is ecologically not strictly comparable with Kurigram South, being located in a different agroecological subregion (North-eastern and Southern Teesta Meander Floodplain).

11.3.5 Identification and Assessment of Environmental Impacts

With construction taking ten years, the pre-project situation is difficult to define. The period 1973-1983 saw major changes in agriculture due to the increasing availability and acceptance of HYV paddy varieties and associated farming practices such as increased use of fertilisers and biocides. Similarly, over the ten years population rose at high annual rates of around 3 per cent, creating greater pressure on land and water resources.

It is clearly important that the environmental evaluation assesses project impacts relative to what would have been the continuing pre-project trends, rather than to specific points in time such as 1973 or 1983. Most of the major biological impacts in the Project Area, for instance, were taking place anyway, due to population pressure (Section 11.5).

Account also has to be taken of the considerable development of pumped tubewell irrigation during the 1980s, the effects of which are sometimes difficult to differentiate from those of the FCD/I Project but which have clearly been mainly responsible for the upsurge in rabi season cultivation, especially of HYV Boro.

Finally, it is necessary to assess the impact of what actually has happened under the Project, rather than the anticipated impact if the Project had worked exactly as planned. Thus there has been no irrigation implemented under the Project; drainage has underperformed to a considerable degree; and flood control has been impaired by public cuts, natural breaches and overtopping of the embankment. Environmental post-evaluation must analyse the impacts of both the successes and failures of the Project.

The initial screening-scoping during the RRA 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/her to agree with or query it; and

- 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 simplicity.

Scaling of impacts is achieved by considering each impact within each AEU 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; and
- 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 source of information has been the Feasibility Study by Techno Consult Eastern Ltd (1971). This is a voluminous work and unlike most FCD/I project planning documents it did give some attention to capture fisheries, to livestock, and to land suitability for irrigation. In respect of the last, however, it failed to recognise the obvious unsuitability of Kurigram South for surface irrigation, especially in the north. Further information has been obtained from the ToR for updating the irrigation feasibility study (BWDB, 1987a) and from the Project Proforma (BWDB, 1987b). Project appraisal took no account of any economic disbenefits relating to fisheries and livestock.

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, during both the RRA and PIE surveys.

FAO (1988) provided much of the 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, although small peripheral tracts of the adjoining rivers' meander floodplains are within the embankment, forming AED R. Khals and dead rivers such as the Buri Teesta and Bamni are considered under wetlands and water bodies in (g) and (h) below.

The main river flow parameters are 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 cumulative impact of all FCD projects in the Teesta and Dharla Basins. This is essential to give a realistic assessment of spatially cumulative impacts which might otherwise be underestimated.

Thus, river flows in both the Teesta and Dharla during the monsoon have been increased by the embankments of several projects concentrating flows along much of their lengths. However, both are large rivers and the relative impact on flow has been only minor, especially as the Kurigram North project embankment remains incomplete, and the Teesta left bank embankment in the Sati Nadi Project to the north has been breached for some years over a distance of several miles.

The impact on the huge Brahmaputra monsoon flow, largely derived from the Himalaya outside Bangladesh, is of course negligible, so that all downstream impacts of the Project are similarly negligible

Increased flows rise more rapidly and earlier, are faster, and last longer. All these effects constitute a negative impact on the environment of the riverine areas.

b) River Quality

Potential key quality factors are sewage, agrochemicals, sediment load (reflected by turbidity), and salinity. Drainage effluent from the Project Area is less than pre-project, when there would have been regular flooding and flushing out. On the other hand, the Project has helped encourage the greatly increased use of agrochemicals. Relative to the substantial flows of the three rivers concerned, even in the dry season, this minor influence is probably negligible, so that no significant impacts arise.

c) River Morphology

River morphology changes mainly as a result of bank erosion, bed scour, or siltation. The increased monsoon flows in the Teesta and Dharla due to Kurigram South and similar projects upstream must increase bank erosion and scouring to some extent, due to greater velocity, and local people claim this to be the case. Again, however, given the size of the rivers this is likely to be only a minor negative impact. The Brahmaputra, as noted, is simply too huge a river to be significantly affected.

d) Flooding and Drainage

The Project was designed to provide flood control and drainage and so to have a beneficial effect on the level, timing, rate of rise, duration and extent of seasonal inundation in the Project Area. For much of the Area this has been achieved, although in fact only about 40 per cent was said to suffer from serious flooding pre-project (Techno Consult Eastern Ltd 1971). Flooding, however, still occurs and at times (as in 1988 and 1991) quite seriously. This is due to:

i. heavy monsoon rainfall and rapid run-off within the Project Area, which even in pre-project times were the main sources of flooding there;

ii. natural breaches of the embankment, especially where it crosses the active meander floodplains (AED R), where it is built mainly of sand and subject to the rivers' fiercest attacks;

iii. drainage congestion, especially in AEDs D,E and R, where run-off and drainage effluent accumulate more rapidly than the sluices (if any) can release it, or levels in the adjoining rivers prevent its escape;

iv. public cuts in the embankment by local people in areas subject to drainage congestion, when later in the season or in following years the rivers rise to higher levels and exploit the cuts;

v. overtopping of the low railway bund which protects the north-western boundary of the Project Area, resulting from Teesta floods through the large unrepaired breach in the Sati Nadi embankment.

The high, sandy ridge of AED A did not suffer significantly from flooding before the Project; rapid run-off and percolation rates, along with elevated relief, make drought rather than flooding the problem here. Consequently the Project has had a negligible impact in AED A.

Table 11.2 Physical Environmental Impacts.

Physical Issues	Environmental Impact										
	Project Area (AEDs)							External Areas			
	A	B	C	D	E	R	Overall	TRA	DRA	BRA	Overall
WATER											
a. River Flow	-	-	-	-	-	-	-	-1	-1	0	-1
b. River Quality	-	-	-	-	-	-	-	0	0	0	0
c. River Morphology	-	-	-	-	-	-	-	-1	-1	0	-1
d. Flooding and Drainage	0	+1	+2	+1	+1	0	+1	-1	-1	-1	-1
e. Groundwater Levels/Recharge	0	0	0	0	0	0	0	0	0	0	0
f. Groundwater Quality	0	0	-1?	0	0	0	0	0	0	0	0
g. Wetlands and Waterbodies Extent/Recharge	0	0	-1	0	-1	-2	-1	0	0	0	0
h. Wetlands and Waterbodies Quality	0	0	-1?	1?	-1?	-1?	-1?	0	0	0	0
LAND											
a. Soil Fertility	0	0	0	0	-1	-1	-1	0	0	0	0
b. Soil Physical Characteristics	0	-1	-1	-1	-1	-1	-1	0	0	0	0
c. Soil Moisture Status	0	0	0	0	0	0	0	0	0	0	0
d. Soil Erosion	0	-1	-1	-1	0	-2	-1	0	0	0	0
e. Soil Salinity	0	0	0	0	0	0	0	0	0	0	0
f. Land Capability	0	+1	+2	+1	+1	0	+1	-1	-1	-1	-1
g. Land Availability	0	0	+1	0	+1	0	+1	0	0	0	0

Source: Consultants
Note: ? = Uncertain impact

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In AED B flooding was never excessive, again due to relatively high elevation, efficient run-off and permeable soils. In general, the Project seems to have had a slight positive impact by guaranteeing the security of the HYV T. Aman paddy and sugar cane now prevalent in the AED B basins. Flooding still occurs over the railway in the south of the AED, from Sati Nadi, but this is not related to or worsened by the Kurigram South Project.

The main improvement in flood control and drainage appears to be in AED C, where the embankment's protection and the initial re-excavation of the drainage lines along the khals and dead rivers have lessened the severity of seasonal flooding considerably.

As a direct result of both the natural and the improved drainage, of course, AED D downstream benefits a good deal less. This is because of the reasons noted in (iv) above, resulting in drainage congestion in the lower areas near the river embankments and around the beels. Since the drainage lines have now largely silted up again, ten years after their re-excavation, the main factors here are the natural north-west to south-east drainage and the embankment and its sometimes inadequate sluices.

The overall impact in AED D is difficult to assess. There are definite improvements in the higher parts of the AED and serious drainage congestion in the lowest parts. Where drainage congestion is less serious, it has been reported as an inadvertent positive impact allowing the cultivation of HYV Boro. Overall it is difficult to imagine that flooding is worse than previously, when run-off would always have been ponded back in the south east by the often higher levels in the Brahmaputra. Thus a minor positive impact is assessed for AED D as a whole.

Similarly, AED E still suffers serious flooding and inadequate drainage, with both Aus and initial Aman crops destroyed in 1991. However, the reasons for flooding are natural ones, as noted, and in pre-project times AED E was mostly beel during the summer. The embankment and drainage re-excavation have clearly aided the ongoing reduction in the extent of the beels there, as population pressure has led to the encroachment of cultivation. Flooding is less, although inadequate project structures on the Kurigram-Rajarhat road have prevented efficient drainage. A much more determined effort to drain this area effectively is needed. To date, a minor positive impact can be attributed to the Project.

It is apparent that AED R should not have been included in the Project Area (see Section 11.6.2 (f) also). Where it has, there has been a reduction in river flooding, counterbalanced by increased drainage congestion in what are mostly relatively low lands. The main negative factor, however, is the considerable risk of catastrophic flooding resulting from embankment failure. The bunds here are subject to the fiercest attacks of the surrounding rivers and are constructed largely of the very sandy alluvium found in AED R. Thus in the north, where the Ratnai and Dharla active meander floodplains effectively merge, there have been repeated breaches and the embankment is in an extremely weak state, while flooding is severe along the unconfined Ratnai. At Siramali, Palashbari, Gharial Danga and Harichari, major structures are necessary to relieve drainage congestion, with only partial success, so that these are areas where both public cuts and natural breaches threaten the sandy bunds. Other small tracts of active meander floodplain embankment are being attacked constantly by the river, as along the Dharla a few kilometres south of Kurigram. Cuts and breaches result in worse flooding than normal overbank river inundation.

The problem arises of how to assess the flooding issue (and the many other environmental impacts associated with it) in AED R. Assessment here is based on the achievements and failures in flood control in AED R to date, but as noted in Section 11.3.5 one of the five key assessment factors is risk of serious environmental damage. Thus the complete security of flooding offered in some years in AED R has to be set against the common breaches and cuts that have occurred there and the very evident risk of similar future events, accompanied as they are by often catastrophic flooding. The assessment made for the key issue of flooding and drainage is that the positive and negative impacts are about balanced.

Overall assessment for the Project Area as a whole gives a minor positive impact.

In the external areas, slight negative off-site impacts area assessed. This is because the river floods that were once able to spread over the lower parts of the Project Area are now ponded back by the embankment, creating worse than previous problems in the riverine areas concerned. Residents outside the embankment complained everywhere that their situation had deteriorated. However, so far there seem to have been few if any public cuts from outside the bund.

e) Groundwater Levels

The high rainfall (2,500 mm per year) and proximity of three major rivers combined with the deep, sandy alluvium guarantee high aquifer recharge rates. Tubewell development is widespread but seems to be having little impact, and is in any case not related to the Project. The prevention of surface flooding by the embankment is unlikely to matter, as the sandy aquifers are obviously continuous under both the rivers and the Project Area.

f) Groundwater Quality

There has been a considerable increase in population and also in the use of agrochemicals, especially for HYV paddy cultivation. Natural filtration should prevent indiscriminate sewage reaching the groundwater to some extent, although in some parts of Bangladesh coeliform contamination of wells has been detected. Given the very permeable soils and their low cation-exchange capacities (which govern their ability to retain applied nutrients), it is possible that the still accelerating use of fertilisers is leading to groundwater pollution, especially by nitrates. This would eventually make drinking water, mostly supplied by hand tubewells, harmful to humans.

As everywhere throughout Bangladesh, but especially in areas of obvious hazard such as Kurigram South, there is an urgent need to initiate a national programme for groundwater quality monitoring. It is becoming increasingly vital to establish current baselines and trends in this respect.

Having said this, it seems evident that the Project will have contributed only indirectly and to a limited degree to indiscriminate sewage via population increase and to the use of agrochemicals. Certainly the Project has encouraged the switch to HYV Aman rice but on a significant scale probably only in AED C, and even there it would have happened on the high land anyway. Thus a doubtful minor negative impact is assessed, but needs confirmation by monitoring. In the external areas the Project has not affected groundwater quality, which is controlled by the large rivers within them.

g) Wetlands and Waterbodies Extent/Recharge

In those parts of the Project Area where wetlands and waterbodies occurred pre-project on a significant scale (AEDs C,D,E and R), the Project has clearly contributed to the shrinkage in beel extents and the shorter duration of flows in the khals and dead rivers. It is also apparent that there was already a pre-project trend for this to occur, due to siltation and to encroaching cultivation as population pressure increased. It is against this trend that the Project's impact must be measured.

Over the last two to three decades major wetlands such as Dewlia Beel have diminished to form a series of small, seasonal beels. Even the large Chakirpasa Beel dries out except for a few deep pockets. The beds of both beels and dead rivers are used for cultivating LV Boro and IRRI rice.

It should be noted that a positive impact here is one which increases wetland recharge and extent, even though this would have negative effects on other environmental issues, such as human use for cultivation and land availability.

The beels in AED E were fed largely by rainfall run-off from surrounding higher land and the Project's impact on them is due to khal re-excavation rather than the embankment. However, re-excavation took place some ten year ago and in AED E its impact was lessened by the inadequate structures passing the Kurigram-Rajarhat road. Since then the khals have silted up and excavation is again needed, this time with better designed structures. At present, seasonal flooding is severe in AED E, as the beels start to re-establish. To date, therefore, the Project has had only a slight negative impact.

In AED C, the combined effects of the embankment and re-excavation have had a negative impact, reducing the extents of beels and allowing the Buri Teesta and Bamni to become farmland along much of their lengths during the rabi season. The proportion of wetland to the total area of AED C, however, was never very great, so that the impact is only minor.

AED D, on the other hand, receives run-off more efficiently although in smaller amounts, which is then ponded within the embankment due to inadequate or insufficient sluices. The net impact seems to balance out, with some beels said to be enlarged slightly, while the lower courses of the dead rivers are silting up.

There is a moderate negative impact in AED R, where regular seasonal river floods occurred prior to the embankment to refill the large oxbows typical of the division. These inflows are now precluded, and in most parts of this AED sluices have been or are being provided to escape accumulated run-off. These influences are countered to some extent by the rapid percolation of subsurface water through the sandy alluvium.

Since AED R is only a small part of the Project Area and in AEDs A, B and D there is a net zero impact, the overall impact on wetlands extent is taken to be slightly negative.

Off-site impact in all the external riverine areas is insignificant. River flows and floods are sufficient to recharge riverine wetlands with or without the bund containing them.

h) Wetlands and Waterbodies Quality

The remarks in (f) concerning groundwater quality apply equally to the surface water bodies, where they are no longer flushed out by seasonal floods. Again, the urgent need for monitoring is evident. The difference from (f) is that any contaminated water would be much more mobile, moving into wetlands wherever they occurred, from higher adjacent or upstream lands where agrochemical use and population growth are greater.

Thus if there is a negative impact, and this can only be suspected in the absence of any real data, it will be in its initial stages and in the main wetland areas; AEDs C, D, E and R.

In the external riverine areas, flushing by the large river flows would make any impact from drainage effluent negligible. Use of agrochemicals outside the bund is limited.

11.4.2 Physical Impacts (Land)

a) Soil Fertility

The main influence of the Project on soil fertility has resulted from the contraction of areas flooded for substantial periods which it has helped bring about. Lengthily flooded land supports aquatic vegetation on which the blue-green algae flourish which are purported to supply nitrogen to the soil. The rotting of this organic material also contributes to soil fertility.

Annual addition of flood sediments are thought to be of limited immediate value to soil fertility. It is interesting to note, however, that farmers in the south of the Project Area, where sediment is silty, claim that the river silt maintained their soils; farmers in the north, however, where sediment is more sandy, did not make this claim. The reality is probably that traditional farming methods and intensities made so little demand upon the soils that the limited beneficial effect of river silt was sufficient to maintain fertility. Also, in the dominantly coarse-textured alluvium of Kurigram South, there are definite soil physical benefits (see (b) below).

Impacts on soil fertility, on the above arguments, should be mainly in those AEDs where lengthy flooding pre-project affected a large proportion of the land. Even then, it is unlikely that the negative impact thus implied in AEDs E and R could be more than minor. Overall the impact is insignificant because of the limited extents of AEDs E and R.

No impact is likely in the external riverine areas.

b) Soil Physical Characteristics

The exclusion of river silt deposition on a pre-project scale must result in a slight negative impact on soil physical characteristics in areas previously flooded. This is due to the generally coarse-textured alluvium in Kurigram South, where the critical soil characteristic determining suitability for cultivation in general and irrigation in particular is the thickness of the silty upper soil level. Silt deposition from floods created this layer and has now been largely prevented from adding to it. Given the sandy subsoils, this means that the trend towards improved moisture holding capacity, infiltration and permeability rates, and soil structure has been interrupted.

The slowness of the depositional process means that this is only a minor impact over the foreseeable life of the Project, although cumulative impact over the very long term would clearly be more serious.

The external riverine areas are not significantly affected, as they continue to be flooded as previously.

c) Soil Moisture Status

This could have suffered a negative impact where the Project affected higher lands, creating even droughtier conditions. However, the discussion in Sections 11.4.1 (d) and (e) show that the higher areas (AEDs A and B) have not been adversely affected. The slight reduction in flooding in AED B is not sufficient to influence dry season soil moisture status significantly. External areas are clearly unaffected.

d) Soil Erosion

This affects only the embankment in Kurigram South, where rainwash and the activities stemming from human use and even occupation are the main factors. The often sandy, non-cohesive construction material is prone to easy erosion, while the elevated sandy soil is a poor medium for the growth of protective grasses, shrubs or trees or as a base for manmade protection such as concrete blocks and gabions.

The main impact is in AED R, where the bund material is particularly sandy, human use and occupation is often concentrated, and the ratio of embankment to AED extent is greatest. AEDs A and E, on the other hand, have little or no embankment within them. Generally, the limited areal extent of the embankment means erosion is only a minor negative impact.

In the external areas, bank erosion is considered as a river morphology factor in Section 11.4.1 (e). No other form of erosion has been induced by the Project there.

e) Soil Salinity

Soil salinity is not an issue in Kurigram South. The highly permeable soils, rainfall of 2,500 mm per year, and occasional incursions of river water with electrical conductivity (EC) of less than 200 micromhos/cm, make any form of salinity impossible. The point is made here only to correct possibly misleading impressions gathered in the RRA that soil and water salinity might one day create problems.

f) Land Capability

The net impact on land capability has been slightly positive, in effect echoing the flooding and drainage impact which has been the main improvement in land capability.

Against this, the minor negative impacts regarding soil fertility and physical characteristics must be considered.

A more detailed environmental analysis at EIA/audit level would apply differential weighting to both the AEDs and to the various environmental issues. Such weighting would show that flooding and drainage together form by far the single most important issues, influencing as they do almost all other issues. In assessing land capability, the influence of this primary issue far outweighs that of soil fertility and physical characteristics, especially as the minor negative impact attributed to them is at the minimal end of the minor range.

In the external riverine areas the increased flooding causes a minor negative impact.

g) Land Availability

This is not significantly affected in AEDs A and B. In AEDs C, D, E and R increased availability of land, especially in the dry season, reflects the decreased extent of wetlands noted in Section 11.4.1 (g). However, in AED R the risk of losing the land to catastrophic flooding creates a balanced impact again; land here should not be regarded as available except in the short term. Overall impact is weighted to give a net minor positive impact.

Land availability in the external riverine areas seems not to have been significantly affected by the increased flooding, which influences the level rather than the extent of seasonal floods.

11.5 BIOLOGICAL ENVIRONMENTAL IMPACTS

Any attempt to assess the biological impacts of projects such as Kurigram South has to take into account parallel trends that were initiated long before such projects were conceived. These are essentially trends associated with the accelerated increase in population pressure both on the physical resources which provide biotic habitats and on the biotic communities themselves. Cultivation, settlements, vegetation clearance, hunting and fishing have all increased as population has soared over the last few decades.

Realistic assessments of the relatively recent Project impacts, therefore, are unlikely to reveal the excessive ecological damage claimed by many detractors of the development planning process. The unplanned population and development of the past has already wreaked ecological havoc in most of Bangladesh.

Table 11.3 summarises the biotic environmental impacts attributable to the Kurigram South Project; not surprisingly, they are very limited.

11.5.1 Biological Impacts (Fauna)

A basic problem in evaluating impacts of either population growth or the Project on all fauna considered in Section 11.5.1 is the total 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 exist, 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 that time fishermen wished or were able to catch. Thus all assessments in this section are based on inference and hearsay, regarding past biotic baselines.

a) Bird Communities/Habitats

There seems to have been a general decline in birdlife in Kurigram South, as elsewhere in most of Bangladesh. However, the main factor in this appears to be growing population pressure and the resultant increase in cultivated area and in hunting birds for food and occasionally sport. While the Project has probably increased human carrying capacity (Section 11.6.2 (a)), it is unlikely to have significantly affected population growth, given current population trends in Bangladesh.

In the Project Area, the small proportion of pre-project wetlands means also that birdlife was likely to have been of lesser significance here than in many parts of Bangladesh,

It is therefore difficult to attribute any significant impact on birdlife except in the two AEDs where favourable waterbird habitats could be expected previously to have been extensive: AEDs E and R. The limited extent of both these AEDs means that the net overall impact is insignificant. No significant impact would be expected in the riverine areas.

b) Fish Communities and Habitats

There has been some negative impact on fish ecology due to the reduction in wetland extent and duration and to the interruption of spawning and recruitment for the major species, especially the carps, by the construction of the embankments. Even so, fish ecology has deteriorated in Kurigram South mainly for the same reasons as the birdlife. Overfishing has followed excessive population pressure, as landless Moslems have joined the traditional Hindu fishermen in exploiting the relatively limited internal fishing areas.

In addition, over the last two to three years, the fish population is reported by everyone asked to have been decimated by the ulcerative disease currently sweeping through Bangladesh. Examples were seen, including large numbers of dead small fish floating on the surface of Chakirpasa Beel. This appears to be of foreign origin and not related, as has been claimed, to increased use of agrochemicals. It is affecting areas of Bangladesh and other countries where agrochemical use is known to be negligible.

Against the long-term overfishing trend and the devastating short-term disease impact, the effect of the Project on fish ecology appears negligible, except perhaps again in AEDs E and R, where fish habitats were once extensive. A minor negative impact is allocated to these AEDs.

The Project is likely to have a minor cumulative negative impact on fish ecology in the two major rivers flanking it, because the embankments of Kurigram South and related upstream projects have interrupted migration and breeding, although overfishing and disease are also reducing river fish populations in these (see Chapter 7). The Brahmaputra, however, is too large for any significant impact.

c) Other Macro-fauna Communities/Habitats

The same comments regarding population pressure apply as for (a) and (b) above Habitats have disappeared as cultivation has extended into previously unused lands, while hunting has affected some species, notably frogs exported as specialist foods to Europe. People interviewed recognised the depletion of wildlife, but rarely considered this to be related to the Project. Unlike in other PIE areas, no complaints about increased rat or snake populations were heard. It seems unlikely that the Project has significantly affected the already low population levels of wildlife in the Project Area, or in the adjacent riverine areas.

Table 11.3 **Biological Environmental Issues**

Biological Issues	Environmental Impact										
	Project Area (AEDs)							External Areas			
	A	B	C	D	E	R	Overall	TRA	DRA	BRA	Overall
FAUNA											
a. Bird Communities/Habitats	0	0	0	0	-1	-1	0	0	0	0	0
b. Fish Communities/Habitats	0	0	0	0	-1	-1	0	-1	-1	0	-1
c. Other Macro-fauna Communities/Habitats	0	0	0	0	0	0	0	0	0	0	0
d. Micro-fauna Communities/Habitats	0	0	0	0	-1	-1	0	0	0	0	0
FLORA											
a. Trees	0	0	0	0	0	0	0	0	0	0	0
b. Other Terrestrial Vegetation	0	0	0	0	0	0	0	0	0	0	0
c. Aquatic Vegetation	0	0	-1	0	-1	-2	-1	0	0	0	0

Source: Consultants

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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. No impact is likely in the external riverine areas.

11.5.2 Biological Impacts (Flora)

a) Trees

The tree populations in the area have not been significantly affected by the Project, although in a few places trees have been planted on the embankment, such as *Acacia nilotica* and *Dalbergia sissoo*, a variety of fruit trees, mulberry for silkworm culture, and the fibre-producing *Bombax* spp.. External riverine areas are not affected.

b) Other Terrestrial Vegetation

There has been no significant impact, as non-aquatic vegetation had already greatly diminished prior to the Project.

c) Aquatic Vegetation

The communities and habitats of aquatic vegetation were concentrated in the wetlands and waterbodies pre-project. They have suffered similar negative impacts to the wetlands regarding extent (Section 11.4.1(g)), while the postulated beginning of quality deterioration (Section 11.4.1(h)) will not have proceeded sufficiently (if at all) to affect the aquatic flora significantly. Again, the external riverine areas are unaffected.

11.6 HUMAN ENVIRONMENTAL IMPACTS

Some of the most important environmental impacts of the Kurigram South FCD/I 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. They can be conveniently grouped into five sub-categories: human use, social, economic, institutional, and cultural issues. Consideration of human impacts in terms of the different AEDs and external areas provides an additional distributional perspective elsewhere in the report.

11.6.1 Human Use Impacts

Chapter 5 considers the overall impacts on cultivation in detail. A first point to be established is that the steady growth in irrigation, using both deep and shallow tubewells and low-lift pumps as well as the traditional treadle pump, is not part of the FCD/I Project. The unimplemented irrigation component as presently being studied for feasibility involves both tubewells (in the north) and a surface gravity distribution system based on a barrage on the Dharla River above Kurigram Town.

In assessing the present Project's impact on cultivation, including irrigation, it is necessary as always to recognise trends that were happening irrespective of the Project before, during and after its implementation.

One major trend, noted above, is that of tubewell and low-lift irrigation in the area, especially the former. This dates from about 1980, accelerating in recent years as private enterprise was given more freedom in this respect. The main result has been the upsurge in HYV Boro cultivation during the rabi season, accompanied in some areas by more and better rabi cropping.

The second trend, to some extent linked to the first, has been the steady spread and acceptance of HYV paddy varieties, from about 1975 onwards, giving roughly double the yield of their local equivalents. Along with this, there has been more emphasis on cash crops such as sugar cane, potatoes and other vegetables.

The impacts of these trends have been very considerable. The question is to what degree they have been facilitated by the Project. The Project's other positive impacts on cultivation relate to the improved land capability and availability (Section 11.4.2), in turn linked to the largely positive impacts on flooding and drainage (Section 11.4.1). Minor negative impacts on soil fertility and physical characteristics (Section 11.4.2) have negligible effects for high yielding or high value crops, which must depend on substantial agrochemical inputs and in rabi on irrigation. The impact on cultivation in the different AEDs is based on a consideration of all these interlinkages.

Project impact in AED A is clearly negligible, as flooding was never significant there and the main problem is droughty soils. Irrigation is having some success but scope remains for a large increase in productivity, using the subsurface water resource.

In AED B the Project's main achievement is a high degree of security for the HYV T. Aman crop widely grown there. Introduction of HYV Aman varieties and, where irrigation is available, HYV Boro would have happened without the Project on this generally favourable land. Thus a slight positive impact is assessed. Flooding was not generally serious in AED B and where it sometimes was, it can still occur due to overtopping of the railway in the north west.

In AED C the positive impact has been substantial. The proportion of paddy basins is somewhat greater and in much of them it is unlikely that HYV T. Aman could have been introduced on the scale it has. Even then, the lower areas still have to grow local Aman, but now with much greater security. HYV Boro has also come in where irrigation is available, there may be a few places where the Project has enabled this by preventing early floods that in the past would have damaged the ripening Boro. A moderate positive impact is assessed.

In AED D very little HYV T. Aman has been introduced, because flooding is still too much. However, in the past even local Aman was sometimes damaged and this crop is now secure in most of the AED. In those areas of drainage congestion where it is not, there is often more than adequate compensation in being able to grow HYV Boro on the residual moisture. A slight positive impact is assessed for AED D.

Table 11.4 Human Environmental Issues

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

Source: Consultants
Note: ? = Uncertain impact.

AED E has benefitted from increased land capability and availability, allowing extensive local Aus and Aman cultivation area over a much larger area than previously. However, the inadequacies of project design and failure to maintain de-silting operations mean that crop security is deteriorating steadily, with disastrous Aus and Aman crops in 1991. Again, HYV Boro on residual water is some compensation, but is still threatened by early flooding. A minor positive impact is assessed, compared to the very limited pre-project opportunities for cultivation.

In most of AED R drainage congestion has limited improvement due to HYV varieties replacing local Aman. Protection from early flash floods for HYV Boro where irrigation is available has been the main positive impact. Against this must be set the high risk of losing the land and any investment in it, should the embankment fail. A net balanced assessment is assumed.

The overall impact on cultivation within the Project is a minor positive one.

In the external riverine areas, the increased flooding has caused a slight negative impact. Cultivation and settlement are surprisingly intensive outside the bund along all three rivers adjacent to Kurigram South. In all three tracts farmers complained, sometimes angrily, about the effects of the embankment on their lives, and especially their crops.

b) Livestock

Chapter 6 shows that any impact on livestock is marginal, and it is difficult to separate impacts from Project-control differences. Green fodder and pasture may have declined, but, if higher value paddy is grown in its place, there should be money available to purchase fodder and feedstuffs to compensate.

Farmers generally did not feel that the Project had any significant impact on livestock within the Project Area. In the external areas, there is increased danger from floods but a ready haven (and source of grazing) in the embankment.

c) Capture Fisheries

Chapter 7 covers the decline in capture fisheries in Kurigram South. However, as noted in Section 11.5.1, it is unlikely that fisheries within the Project Area were as important pre-project as in other parts of Bangladesh. Wetlands proportionately were never very extensive.

The extent of wetlands and important fishing localities was high only in AEDs C, D, E and R, all of which have probably suffered slight impacts due to the Project. The main factors in capture fisheries here, as throughout the area, have been disease and the population pressure leading to overfishing noted in Section 11.5.1(b).

A cumulative minor negative impact is attributed to Kurigram South and related projects in the DRA and TRA, caused by interruption of migration and breeding by embankments. The impact on the Brahmaputra is considered to be negligible, in view of its size.

d) Culture Fisheries

There has been some development of culture fisheries in the Project Area but no new fishponds were seen during the environmental traverse. Government hatcheries exist and at least one major fishpond venture (Chapter 7), but these are not much in so large an area and they are in any case not much related to the Project. Fisheries extension is not linked with the Project, but only some 50 per cent of fish ponds now enjoy flood protection (Chapter 7). No significant impact can therefore be discerned.

Fishpond development in newly protected land is a common achievement for FCD projects. What acts against such development in Kurigram South is the very permeable nature of the sandy subsoil. It is often impossible to maintain water levels in ponds during the dry season, especially on the higher lands. Excessive pumping of groundwater would be needed, and to some extent self-defeating. Otherwise, some form of lining is needed.

e) Afforestation

Limited tree planting has occurred on the embankment, as noted in Section 11.5.2, but there is scope for much more. Nowhere is it sufficient to constitute a significant impact.

f) Agro-industrial Activities

The number of rice mills has increased, as paddy production has risen. Mostly, however, this has been due to irrigation and HYV varieties that would have been grown anyway. The Project has probably contributed sufficiently to warrant a slight positive impact in only AED C of the areas where agro-industrial activity is concentrated (AEDs A,B and C).

g) Transport Communications

Boat transport was never as important within the Project Area as in many wetter parts of Bangladesh, except perhaps briefly at the height of floods. This is indicated by the relatively dense network of roads, including a considerable length of all-weather road (Chapter 8).

The embankment is not always suitable for motor transport, because it is so easily eroded, but is still a conduit for other transport forms. In addition, the Project must provide substantial protection to village roads and some kutcha and even pukka roads. However, damage when it does occur, due to breaches, cuts and overtopping, is often greater than in the past. At least two bridges were seen to have been destroyed by the 1991 floods in the north west, one on the main highway.

The main positive impacts are in the wetter areas: AEDs C, D and E. AED R is considered to have only a balanced impact because of the risk of large-scale damage to the bund and other communications there and the very poor condition of the bund.

The higher flooding outside the embankment does not significantly increase the difficulties of transport during the floods, most of which is by boat. On the other hand, the embankment adjoins the riverine areas, providing generally flood-free access. This represents at least a minor positive impact.

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h) Infrastructure

The same comments apply as in (g) above, except that damage to houses and property seems to have increased outside the embankment, giving a slight negative impact there. Chapter 8 considers infrastructure further.

i) Domestic Water Supply

The discussion in 11.4.1(f) indicates the various impacts here, which relate essentially to the Project's possible effect on ground water quality. However, it is stressed that no data are available and that monitoring is urgently needed to verify any deterioration. There is little likelihood of recharge and levels being affected (Section 11.4.1e).

The result is an uncertain (?) slight negative impact in AED C, the only area if any, thought to be significantly affected by deteriorating groundwater quality.

j) Sanitation

The main fear here is that the embankment prevents the previous flushing action to clear accumulated sewerage pollution in the low-lying areas and beels. There seems to have been a widespread increase in the use of latrines since pre-project times and this, plus no reports of any increase in related diseases, indicates no real impacts on sanitation.

k) Recreation

No significant impact occurs, because of the negligible recreational opportunities.

l) Energy

Again there is no significant impact, as the project operation involves little direct use of energy except in repair and maintenance work.

11.6.2 Social Impacts

a) Human Carrying Capacity

The increased land capability and availability have achieved a corresponding increase in human carrying capacity, due basically to the reduction in flooding. However, for the reasons discussed in Sections 11.4.2 (f) and (g), the positive impacts are slight except for AED C, where a more substantial increase has been achieved, and for AED R, where the risk of catastrophic flooding precludes a genuine rise in carrying capacity.

Increased flooding in the riverine areas has slightly reduced human carrying capacity there.

b) Demography

The Project itself has probably not significantly influenced demographic structure and trends, although it might have had a very slight effect in reducing the out-migration of young to middle-aged males seeking work elsewhere. Certainly the inexorable population growth would have occurred with or without the Project.

c) Gender

Chpater 9 indicates a negligible differential impact of the Project on women. The role and status of women are unchanged, and women do not appear to have received any additional benefit or disbenefit. Some women obtain some employment in embankment repair, but most of the additional work goes to men.

d) Age

No obvious impact arises, unless the increased agricultural activities offer more employment for the old or take children out of school too early. Such impacts are not likely to be significant, even if present, because of the Project's limited responsibility for the upsurge in activity.

e) Health and Nutrition

The increased food supply partly achieved by the Project in some AEDs must represent a benefit in this respect. No health problems were reported that could be attributed to the Project, except one or two complaints of increased mosquitoes. Protein deficiency due to any decline in fisheries and possibly livestock is mainly caused by other factors. The various conflicting factors suggest that the only significant net impact occurs in AED C.

f) Disruption, Safety and Survival

There seems to be a general awareness of greater security in the Project Area. Floods still occur due to breaches, cuts and overtopping, however, and this sense of security may be misplaced. There are four particular areas of concern, two of them relating to specific sites.

i. The general weakness of the embankment because of the mainly sandy construction material and the high degree of soil erosion - see Section 11.4.2 (d).

ii. The particularly sandy and weak embankment stretches within the tracts of AED R which have mistakenly been included in the Project. Apart from the weaker than usual bunds, their position on the active meander floodplains ensures more frequent and more powerful attacks by the rivers than elsewhere.

iii. At Kishorpur Regulator the Teesta in 1991 totally destroyed a protective groyne some 200-300 m in length. This may have resulted from successful bund protection upstream at Biddha Nanda, from which the Teesta seems to have swung away, creating a new line of attack at Kishorpur. The outcome is that only the regulator now stands between the Teesta and its old course, the Buri Teesta, which exits via the regulator. The Buri Teesta has a substantial channel so that if the Teesta enters it, it could partially or wholly divert right across the Project Area, to join the Brahmaputra at Chilmari Regulator. In so doing, it would cause devastation along the line of the Buri Teesta, not least in the Upazila town of Ulipur situated midway down the Buri Teesta (Figure 11.1). The southern part of the Project Area could then become an island. This could be very difficult and costly to prevent.

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iv. At Sannyashil village on the Dharla River, a natural breach occurred in 1990-91. A new bund has been constructed behind this which, as it is on a relatively high terrace, seems adequate to contain Dharla floods. However, the same low bund continues for a kilometre to the east to the mouth of the Sannyashil Khal, a large, well-defined channel re-excavated during the late 1970s. Only a low ridge separates this channel from the Dharla, even in November, and this year a narrow but deep cut has been made by local people, presumably to release water to catch fish. Meanwhile, the groyne built just upstream of the breach area seems to be creating a current which leads the Dharla to attack at exactly this point. The next large flood is likely to exploit the narrow cut, demolish the low embankment closing the Sannyashil Khal, and head due south down this large channel into the heart of the Project Area.

It is likely that there are other instances of impending catastrophic flooding and, given the huge costs involved in dealing adequately with any of those or the four instances above, it is difficult to see what can be done to assure safety.

The lowest areas of the Project Area (AEDs C, D and E) are vulnerable, suffering a moderate negative impact only because real devastation would be fairly localised. AED R, as noted, is particularly liable and vulnerable, and suffers a major negative impact in respect of safety.

The increased flooding in the external riverine areas represents a general slight negative impact.

g) Land Ownership

This appears unaffected by the Project as yet, regarding changes in land ownership. However, there is a general minor negative impact in all AEDs and external areas where land was lost to the embankment, especially as reparation appears often to have been inadequate.

h) Equity

The view of most people questioned was that there had been a proportional distribution of project benefits, possibly because they are not so great. The larger landowners clearly profit more, but even the landless and underprivileged women appear to have benefitted slightly. Traditional fishermen however, are clear losers. Impact on equity is a subject that requires more intensive study. It is discussed further in Chapter 11. The main benefits to the better-off have been due to irrigation rather than to the Project. When the Project has had a positive impact, it has probably led to a slight increase in inequity.

In the riverine areas, there is again some slight inequity, where the better-off tend to have land on both sides of the embankment and so have compensation for the increased flooding outside it. However, erosion which makes people landless is unlikely to have been affected by the Project.

i) Social Cohesion

This does not seem to have suffered, partly for the reasons in (h). Even the angry residents of the external areas seem not to have resorted to public cuts to alleviate their situation.

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j) Social Attitudes

Generally social attitudes were positive within the Project Area, roughly in proportion to the positive impacts on cultivation, added to by the general feeling of increased safety from major flooding (however mistaken this might be, especially in AED R).

In the external areas, social attitudes were decidedly negative, with often considered resentment of the Project. This was ameliorated in places by the appreciation of the embankment as a place of refuge for people and livestock during floods.

11.6.3 Economic Impacts

The three main potential impacts on the people are on incomes, employment and land values. These have all received positive impacts due to the Project (Chapter 10), generally in proportion to the impacts on cultivation. The only AED not significantly affected, therefore, is AED A, where economic gains have been due largely to irrigation. AED R has benefitted to date in most tracts, but has only net balanced impacts because of the high risk of future losses in respect of all three issues. The positive impacts are countered to a small degree by the losses caused by the Project to capture fishermen in some AEDs (Section 11.6.1(c)), but not sufficiently to modify the assessments.

Corresponding minor negative impacts on incomes probably occur beyond the bund in the riverine areas, sometimes alleviated by people owning land on both sides of the embankment. Employment and land values may also be affected, but not significantly.

Credit availability appears to be unaffected (Section 10.6.2).

11.6.4 Institutional Impacts

a) Institutional Activity/Effectiveness

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 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.

BWDB appear to be fulfilling their role of operation and maintenance of the Project moderately well, given the constraints imposed upon them. There are, however, a number of shortcomings which constitute negative impacts, as defined above: poor embankment maintenance; drainage congestion; drainage channel improvement; and undue expenditure in AED R. Chapter 4 discusses O&M further.

Embankment maintenance and the repair of breaches and cuts are generally behind schedule, as would appear inevitable given the poor construction material and the number of cuts to relieve drainage congestion.

Drainage congestion in AEDs D and E itself requires better O&M of existing sluices and the planning, design and implementation of enlarged and additional sluices.

More effective drainage requires the re-excavation of khals and dead river channels which have silted-up during the last ten years, affecting mainly AEDs C, D and especially E.

The continuing efforts to maintain the AED R tracts would seem to be ineffective in terms of cost. The expenditure on the embankments and regulators at sites like Siramali, Palashbari and Harichari could be used with much greater long-term returns to alleviate drainage congestion in AEDs D and E. Even with such expenditure, the risks inherent in trying to prevent large rivers from following their natural paths is excessive.

The demands of the Project, therefore, seem to have had generally negative impacts on BWDB's institutional activities and effectiveness, especially in AEDs D, E and R.

b) Public Participation

There is no evidence of public consultation in the project planning stage, but people have participated, through Food For Work (FFW) programmes, in much of the construction of the Project. Since completion, there have been no significant institutional impacts on public participation. An effort may be required in this direction if the problems in (a) above are to be righted.

11.6.5 Cultural Impacts

It is difficult to see how the Project has significantly influenced cultural heritage or scenic qualities in the Project Area. There appear to be no particular historical, archaeological or more recent sites of cultural note within the area or the adjacent riverine lands.

Cultural continuity has received slight negative impacts in the main wetland areas (i.e. in AEDs C, D, E and R) because of the decline of the traditional fishermen. Usually these are Hindu and add to social and cultural diversity. Some have now gone elsewhere, including India, whilst others have forsaken their traditional ways to become landless labourers.

Overall, the quality of life in the Project Area has improved slightly due to the Project, again broadly in proportion to improvements in crop productivity. However, should any of the dangers highlighted in Section 11.6.2 (f) come to pass, the quality of life would be abruptly threatened in certain localities. All of AED R suffers from high risk and so is allocated a net minor negative impact.

Outside the embankment, the increased flooding has caused a slight deterioration in the quality of life.

11.7 ENVIRONMENTAL SCREENING

The originally planned primary project activities were flood protection, improved drainage and a comprehensive gravity surface irrigation system. Scoping shows that neither of the first two of these has been fully achieved, while the last has not so far been initiated.

A degree of flood protection has been achieved but the threat of catastrophic flooding remains, especially in certain localities (Section 11.6.2(f)). Fairly regular flooding still occurs from the north west caused by overtopping of the inadequate railway embankment.

Some ten years after initial re-excavation the main drainage lines along khals and dead river channels have silted-up again and require re-excavation. Drainage congestion in low areas near the embankment results from the inadequacy or lack of sluices.

The Project has achieved little regarding irrigation: in some places surface irrigation has been encouraged by protection from early flooding and in some drainage congestion areas water is available for rabi season irrigation or direct cropping. However, the delay in implementation of surface irrigation has allowed the enormous potential of tubewell irrigation in this area to be demonstrated and attention to be drawn to Kurigram South's unsuitability for large-scale surface irrigation, even in the south.

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, although drainage also contributes in the lower areas.

Environmental screening uses the scoping exercise carried out in Sections 11.4-11.6 to evaluate project activities in terms of their influence on environmental impacts.

11.8 CONCLUSIONS AND RECOMMENDATIONS

11.8.1 Conclusions

Conclusions can be summarised in terms of the main environmental impacts of the Kurigram South FCD/I Project on the Project Area and the external riverine areas. Environmental impacts have been assessed by environmental scoping in Sections 11.4-11.6 and are presented in Tables 11.2-11.4. The agroecological divisions (AED) are defined on Figure 11.1 and in Table 11.1.

a) The Project Area

There have been no major positive impacts in the Project Area as a whole and the only overall moderate positive impact has been on social attitudes: people, especially in the lower areas, feel that the Project provides security from floods.

There are also no major negative impacts overall, and only two moderate negative impacts taking the Project Area as a whole. The latter in fact are contradictory to the positive impact noted above, in that they relate to increased danger of catastrophic flooding and the BWDB's likely inability to do much to prevent it (due mainly to the technical difficulties and excessive costs involved).

There are four areas of particular concern in relation to catastrophic flooding risk, discussed in Section 11.6.2 (f):

i. the general weakness of the embankment throughout the Project Area;

ii. the particular weakness and vulnerability in the AED R tracts;

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iii. Kishorpur Regulator, where there is a danger that the Teesta could re-enter the Buri Teesta channel;

iv. Sannyashil Khal "confluence" with the Dharla, where the Dharla could enter the khal channel and penetrate the Project Area.

The limited impact of the Project on the Project Area overall results from the following issues.

i. Pre-project flooding was a problem in only 40 per cent of the Project Area and even then was in large part due to heavy monsoon rainfall and run-off within the Area.

ii. Natural breaches and public cuts are common, allowing many lower localities to be flooded still; the increased danger of catastrophic flooding is noted above.

iii. Drainage congestion due to inadequate sluice design and distribution has resulted in lower areas, especially near the embankment (AED D), suffering worse flooding than pre-project.

iv. Overtopping of the inadequate railway embankment in the north west continues as it did pre-project.

v. Lack of maintenance of the drainage channels has reduced effective drainage, especially in the central beels (AED E).

vi. No irrigation component has been implemented, although the possibility remains that a totally unsuitable surface irrigation scheme could be imposed on the area. The scope for further tubewell irrigation development is evident.

vii. Although a number of major changes have taken place in the Project Area, these are the result mainly of trends occurring irrespective of the Project and generally receiving only minor and/or localised additional impacts from it. These include the more obvious negative ecological impacts such as wetlands retreat and the decline of birds, fish and other wildlife; hence the almost negligible biotic impact of the Project. Similarly, marked changes in human issues only partially influenced by the Project include the substantial increase in agricultural productivity, the decline of capture fisheries and the growing inequity between the rich and the poor.

From points (i) - (v) above it can be seen that the Project's overall impacts have a marked variability in their geographical distribution within the Project Area. The AED approach was devised to illustrate this variation.

Thus it is clear that the Kurigram Ridge (AED A), representing 6 per cent of the Project Area, has been barely affected by the Project and the Northern High Lands (AED B: 15 per cent) only slightly so.

The extensive Upper Buri Teesta-Bamni Floodplains (AED C: 37 per cent), on the other hand, is the AED to have most clearly benefitted, with significantly reduced flooding allowing a considerable switch from local to HYV Aman rice.

The similarly extensive Lower Buri Teesta-Bamni Floodplain (AED D: 29 per cent) and the more localised Central Beels (AED E: 5 per cent) have received both positive and negative impacts, with the former sufficient to create a net minor positive impact in both areas.

In many ways the most critically affected AED consists of several small tracts of Active Meander Floodplains (AED R: 8 per cent), nearly all along the Teesta and Dharla Rivers. These have been erroneously included in the Project Area and represent some of the main areas of catastrophic flood hazard, which can only be avoided by protective works out of all proportion to the returns from the limited extents of land protected. The high degree of risk implies an overall negative environmental impact for AED R.

b) External Impact Areas

Tables 11.2-11.4 show the general minor negative physical and human impacts of the Project on the adjacent riverine areas along the Teesta, Dharla and Brahmaputra Rivers. There have been negligible biotic impacts there.

The basic cause has been the slight increase in flooding resulting from the embankment preventing the spread of rising river waters over the adjoining Project Area.

Any cumulative downstream effects of the Project, in association with other FCD projects upstream, are completely masked by the sheer size of the Brahmaputra River flows, largely arising outside Bangladesh.

11.8.2 Recommendations

Recommendations are given below.

i. Urgent attention must be given to areas particularly threatened by catastrophic flood hazard: much of AED R, Kishorpur Regulator and the Sannyashil Khal, along with any other weak spots known to BWDB along the embankment. Effective protection is probably beyond the means of Government to provide and support should be considered by the international donors (for example for a retreat from the active floodplain).

ii. In the case of AED R, a cost-effectiveness study is needed to show whether even now it is worth trying to retain this land within the Project. For instance, the embankment would probably be better along the right bank of the Ratnai River.

iii. The possibility and cost-effectiveness of raising the railway embankment south of Lalmonirhat should be examined; the real solution may be to close the large breach in the Teesta left bank bund to the north-west of the railway.

iv. The drainage lines along khals and dead river channels urgently require re-excavation, with repair or reconstruction of structures along them to allow efficient flow.

v. The need for additional or larger sluices in the embankment to relieve drainage congestion should be examined and suitable measures taken.

vi. Any proposals for major surface irrigation development should be carefully scrutinised in terms of real costs and benefits, and compared realistically with the alternative of promoting private-enterprise tubewell development on a large scale.

vii. Ways of encouraging culture fisheries, possibly using lined ponds, should be investigated and implemented.

viii. Attention should be given to the plight of particularly impoverished people: the landless, traditional fishermen, and underprivileged women, by ensuring them a real role in future development such as irrigation and fish culture.

ix. The potential for embankment protection and agricultural production by means of planting trees, shrubs and/or grasses should be examined in depth. There is currently confusion and disagreement between disciplines on the safety and value of afforestation and other planting on the embankment. These need to be resolved in an area like Kurigram South, where embankment instability is a major problem. Given the general negative impact of the Project on people outside the embankment, ways should be explored of allocating rights of embankment afforestation, cultivation, grazing, and settlement (which is common on the embankment) as compensation to affected groups.

x. Monitoring programmes for certain critical environmental parameters should be established at the earliest opportunity. Such parameters include groundwater levels and quality, wetland extents and quality, and soil physical and chemical characteristics. A baseline survey of biotic parameters such as birdlife, fish, terrestrial wildlife, and aquatic micro-biota would show if these are of sufficient importance in Kurigram South to justify future monitoring; compared to other parts of Bangladesh, it is likely that they are not.

xi. Given the generally limited environmental impact of the Project as a whole, the need for a future more detailed environmental evaluation (i.e. project environmental audit) is less than in many other projects. It would become important if either large-scale surface irrigation were implemented or large-scale catastrophic flooding took place. Both would have major environmental impacts.

None of the above recommendations is easy to implement and obvious solutions are not immediately available. They represent some of the key challenges faced by the current FAP programme, as they highlight many of the shortcomings of previous FCD and FCD/I development in Bangladesh.

12 ECONOMIC EVALUATION

12.1 INTRODUCTION

The Kurigram South Project was conceived as a flood control, drainage and irrigation project in the 1960s. Annual flooding in the pre-project period led to extensive damage to the Aus and Aman crops. Thus the aims of the Project included protection of Aus and Aman and provision of supplementary irrigation for Aus and Aman. While the irrigation component of the Project was never formally abandoned, it has never been implemented and strong reservations have been expressed about surface irrigation development in the area (Chapter 2).

This Chapter presents an economic re-evaluation of the Project based on agricultural and fisheries impacts. It should be noted that more than in other projects evaluated by FAP 12 using PIE methods, the economic calculations for Kurigram South are subject to much uncertainty. Primarily this arises from the very long implementation period of the Project which has been listed as ongoing for nearing 20 years. Hence documentation of Project costs is unclear and the figures used in this assessment may not reflect the resource cost actually incurred, or the resource cost which would be incurred now to construct the same infrastructure.

12.2 PROJECT COSTS

The gross Project area is around 64000 hectares and the net benefited area is about 50000 hectares. There is no comprehensive breakdown of construction costs incurred to date. The revised PP (BWDB, 1987b) details the costs incurred up to 1987 in 1987 financial prices. However, this indicates that 103 km of embankment were built at a cost of just over Tk 12 million in 1987 prices (using FFW), this appears to be a very low estimate of the economic cost involved in building major river embankments but no other definite data are available. However, the FAP 12 team estimated based on field observation and average FFW payment rates that 157 mt. of wheat would be needed to construct 1 km of embankment in Kurigram, which implies a much higher construction cost.

Beyond 1987 the revised PP details a work programme costing Tk 5101 million (1987 financial prices) for implementation from 1987-88 to 1994-95. However this was for the original plan (surface irrigation). There is no evidence to indicate that the programmed expenditure on construction between 1987 and 1991 had been incurred since there are no irrigation canals present in the Project nor has work on the proposed Barrage started. Against this details of some expenditures under Flood Damage Repair (FDR) programmes were available, but other expenditures during the period since 1987 may have gone unrecorded. Hence the costs in the PP up to 1987 may underestimate true costs, while actual construction expenditure after then is uncertain.

Table 12.1 details the construction costs based on the revised PP up to and including 1990 (which should be treated with caution - see above). The total capital (financial) cost of the Project on this basis may have been Tk. 683.6 million (1991 prices) or Tk. 13672 per hectare (of net benefited area). This capital cost is not strikingly different compared to a number of projects, for example, Kolabashukhali (Tk. 12041/ha.), Zilkar Haor (Tk. 17810/ha.), Kahua Muhuri (Tk. 11512/ha.).

Table 12.1 **Project Economic Costs, 1991 Prices**
Taka, millions

Year	Capital cost
up to 1987	122.6
1988	72.9
1989	59.3
1990	238.3
O&M per annum (from 1985)	31.8

Source and Notes: Based on revised PP (1987). Conversion factors for shadow pricing were derived from FPCO (1991). The Agricultural Wage Rate Index and the Construction Cost Index (BBS, 1991) were used as inflation indices to arrive at 1991 prices.

O&M costs are less uncertain, Chapter 4 examined staffing and FFW maintenance. Details of all O&M related expenditure during 1988-89 to 1990-91 were available from BWDB. These indicate financial costs (current prices) in the range of Tk 33-44 million, resulting in the economic cost in Table 12.1. However, these figures include investments under FDR programmes which cannot be expected to continue at the same rate for the life of the Project - for example bank protection, town protection, and the three regulators under construction. Removing the FDR costs would leave annual O&M expenditure in the order of Tk 12 million (GOB budget plus FFW). However, the current level of maintenance implicit in this estimate is inadequate (Chapter 4), and it is likely that continued expenditure will be incurred for repairs to breaches and erosion.

Hence the base case for economic analysis takes the PP data and last three years of O&M expenditure as the basis of Project costs, but sensitivity analysis is undertaken for alternative cost streams.

12.3 AGRICULTURAL IMPACT

The major Project impact on agriculture has been on monsoon paddy, namely Aus and Aman, and in particular on T. Aman (HYV/LV) which exhibits significant area and yield differences with the control. It has been suggested that Boro may have benefited from the Project - the area and yield of Boro is slightly higher in the Project area than in the control area (Chapter 5), although HYV Boro has expanded considerably in both areas independently of the Project. This benefit could be from the extra residual moisture resulting from drainage congestion (see Chapter 5).

Tables 12.2 and 12.3 indicate changes in gross output value and in costs per hectare assuming that the Project benefited all paddy. The gross Project impact is estimated as Tk. 3612 and the cost differential is Tk. 659.2, yielding a net impact of Tk. 2953 per hectare of gross benefited area. Extrapolating for the whole Project, total net benefits arising from the agricultural impact, are estimated at Tk. 275 million. It should be observed that the agricultural yields reported can be treated as normal for both the Project and control areas, but do not allow for differences in variability during monsoon conditions between with and without Project conditions.

Table 12.2 Gross Returns from Paddy Production per Hectare (1991 prices)

	Project	Control
Average Yield mt. (all paddy)	2.67	2.19
Gross Return (Paddy)		
Financial	15157.6	11940.9
Economic	14702.9	11582.7
By products		
Financial	4700	4100
Economic	3854	3362
Gross Returns (Total)		
Financial	19857.6	16040.9
Economic	18557.0	14944.7
Gross Project Impact (Economic)/ha. : Tk. 3612		

Source: PIE Survey, see Section 5.3.3
Note: Conversion Factors derived from FPCO (1991).

Table 12.3 Per Hectare Economic Costs of Paddy Production (1991 prices Tk/ha.)

Crop	Project		Control	
	Area (%)	Cost (Economic)	Area (%)	Cost (Economic)
B. Aus	14.9	4576.1	15.6	4590.5
T. Aus (L)	0.5	6607.6	0.5	14394.0
T. Aus (HYV)	3.9	9315.8	1.7	9381.4
B. Aman	0.4	5811.5	2.3	3395.7
T. Aman (L)	46.6	5155.7	54.0	4903.7
T. Aman (HYV)	7.5	6798.4	3.1	6571.4
Boro (L)	0.5	2195.2	1.7	5451.8
Boro (HYV)	25.1	10648.1	21.1	9959.2
Aus/Aman (Mixed)	0.4	4191.3		-
Average (weighted)	100.0	6726.8	100.0	6067.6
Change (Tk./ha.)	659.2			

Source: PIE Survey.
Note: Conversion Factors for Pricing based on FPCO (1991)
Area % is % of total paddy area

If instead Boro is treated as unaffected by the Project then benefits can be calculated on the basis of monsoon season paddy (there is a negligible difference in Jute yield and area between Project and control areas). In this case the weighted mean monsoon paddy yield in the Project is 2.3 mt./ha. and in the control area 1.95 mt./ha. Adjusting the figures in Tables 12.2 and 12.3 for monsoon paddy only gives a gross Project impact of Tk 2678 per ha of paddy and a cost differential of Tk 486 per ha of paddy, implying a net benefit per ha of paddy of Tk 2192. This is extrapolated over a reduced area of paddy (since Boro is not included), and implies a total net benefit arising from impacts on Aus and Aman paddy of Tk 127 million per year (this is treated as a low benefit alternative to the base case).

12.4 FISHERIES LOSSES

Chapter 7 noted that capture fisheries have been adversely affected by the Project but not as severely as in some other projects because of the relatively smaller area of floodplain and beels in the Project. In Table 7.17 it was estimated that the net fisheries loss, after allowing for growth in fish cultivation, was between 91 and 151 mt. a year. Using the standard FAP 12 valuation assumptions (a net economic value in 1991 prices of Tk 26.6 per kg) gives an upper estimate of fish loss of Tk. 4 million per annum, which is a very small fraction of agricultural benefits.

12.5 OTHER IMPACTS

Other impacts, both positive and negative have been identified, but not quantified. These include the small negative impact on livestock (Chapter 6), the positive impact on transport and communication (Chapter 8), some gain from flood protection for non-agricultural activities and homesteads (Chapters 8 and 10), a lack of any specific benefit to women (Chapter 9), and the uneven distribution of benefits between households (Chapter 10). An unintended adverse impact has been to heighten social tensions resulting from the familiar phenomenon of drainage congestion, water-logging and public cuts. These impacts are not included in the benefit-cost calculations, but this does not mean that they should be ignored.

12.6 BENEFIT-COST ANALYSIS

The post-project economic benefit-cost analysis was conducted on the basis of the Project impacts on agriculture (paddy) and fisheries. Other impacts are identified in the relevant chapters and quantified in non-economic terms where possible, they are summarised on qualitative scales in Chapter 11.

The base run for estimation of EIRR uses the point estimates of yields for all paddy derived from the PIE survey. Deducting the fisheries losses from the agricultural benefits leaves net economic benefits of Tk. 271 million, yielding an EIRR of around 22 per cent (Table 12.4). A 10 per cent yield reduction consisting of a 5 per cent decline in yields in the Project area and a 5 per cent increase in the control area, for all paddy, takes the EIRR to well below 12 per cent, the opportunity cost of capital assumed in FAP.

A similar sensitivity test was conducted, by allowing yields to take on maximum and minimum values on the basis of standard errors estimated at the 75 per cent confidence level. These then provide maximum and minimum limits around the EIRR (Tables 12.5 and 12.6) derived on the basis of the point estimates. This gives a range for the EIRR of 2.4-31 per cent.

Table 12.4 Economic Cash Flow, Kurigram South Base Run

(Constant economic values, 1991 prices,million Taka

Year	Fish Losses (Tk)	Agricultural Benefits 1/	Capital Costs	O&M Costs	Total Costs	Net Economic Benefits
1974			4.9		4.9	-4.9
1975			4.9		4.9	-4.9
1976	0	0	4.9		4.9	-4.9
1977	0	0	4.9		4.9	-4.9
1978	0	0	4.9		4.9	-4.9
1979	0	0	10.9	0	10.9	-10.9
1980	0	0	10.9	0	10.9	-10.9
1981	0	0	10.9	0	10.9	-10.9
1982	0	0	10.9	0	10.9	-10.9
1983	0	0	10.9	0	10.9	-10.9
1984	-4	23.72	10.9	0	10.9	8.82
1985	-4	23.72	10.9	30.4466	41.3466	-21.6266
1986	-4	39.97	10.9	30.463	41.363	-5.393
1987	-4	39.97	10.9	34.5958	45.4958	-9.5258
1988	-4	78.72	72.9	31.816	104.716	-29.996
1989	-4	78.72	59.3	31.816	91.116	-16.396
1990	-4	133.72	238.3	31.816	270.116	-140.396
1991	-4	271.22		31.816	31.816	235.404
1992	-4	271.22		31.816	31.816	235.404
1993	-4	271.22		31.816	31.816	235.404
1994	-4	271.22		31.816	31.816	235.404
1995	-4	271.22		31.816	31.816	235.404
1996	-4	271.22		31.816	31.816	235.404
1997	-4	271.22		31.816	31.816	235.404
1998	-4	271.22		31.816	31.816	235.404
1999	-4	271.22		31.816	31.816	235.404
2000	-4	271.22		31.816	31.816	235.404
2001	-4	271.22		31.816	31.816	235.404
2002	-4	271.22		31.816	31.816	235.404
2003	-4	271.22		31.816	31.816	235.404
2004	-4	271.22		31.816	31.816	235.404
2005	-4	271.22		31.816	31.816	235.404
2006	-4	271.22		31.816	31.816	235.404
2007	-4	271.22		31.816	31.816	235.404
2008	-4	271.22		31.816	31.816	235.404
2009	-4	271.22		31.816	31.816	235.404
2010	-4	271.22		31.816	31.816	235.404
2011	-4	271.22		31.816	31.816	235.404
2012	-4	271.22		31.816	31.816	235.404
2013	-4	271.22		31.816	31.816	235.404
2014	-4	271.22		31.816	31.816	235.404
		EIRR %			22.37	
		BCR @ 12%			2.05	

Table 12.5 Economic Cash Flow, Kurigram South Upper Confidence Interval

(Constant economic values, 1991 prices,million Taka

Year	Fish Losses (Tk)	Agricultural Benefits 1/	Capital Costs	O&M Costs	Total Costs	Net Economic Benefits
1974			4.9		4.9	-4.9
1975			4.9		4.9	-4.9
1976	0	0	4.9		4.9	-4.9
1977	0	0	4.9		4.9	-4.9
1978	0	0	4.9		4.9	-4.9
1979	0	0	10.9	0	10.9	-10.9
1980	0	0	10.9	0	10.9	-10.9
1981	0	0	10.9	0	10.9	-10.9
1982	0	0	10.9	0	10.9	-10.9
1983	0	0	10.9	0	10.9	-10.9
1984	-4	44.7	10.9	0	10.9	29.8
1985	-4	44.7	10.9	30.4466	41.3466	-0.6466
1986	-4	73.2	10.9	30.463	41.363	27.837
1987	-4	73.2	10.9	34.5958	45.4958	23.7042
1988	-4	141.6	72.9	31.816	104.716	32.884
1989	-4	141.6	59.3	31.816	91.116	46.484
1990	-4	238.2	238.3	31.816	270.116	-35.916
1991	-4	481.2		31.816	31.816	445.384
1992	-4	481.2		31.816	31.816	445.384
1993	-4	481.2		31.816	31.816	445.384
1994	-4	481.2		31.816	31.816	445.384
1995	-4	481.2		31.816	31.816	445.384
1996	-4	481.2		31.816	31.816	445.384
1997	-4	481.2		31.816	31.816	445.384
1998	-4	481.2		31.816	31.816	445.384
1999	-4	481.2		31.816	31.816	445.384
2000	-4	481.2		31.816	31.816	445.384
2001	-4	481.2		31.816	31.816	445.384
2002	-4	481.2		31.816	31.816	445.384
2003	-4	481.2		31.816	31.816	445.384
2004	-4	481.2		31.816	31.816	445.384
2005	-4	481.2		31.816	31.816	445.384
2006	-4	481.2		31.816	31.816	445.384
2007	-4	481.2		31.816	31.816	445.384
2008	-4	481.2		31.816	31.816	445.384
2009	-4	481.2		31.816	31.816	445.384
2010	-4	481.2		31.816	31.816	445.384
2011	-4	481.2		31.816	31.816	445.384
2012	-4	481.2		31.816	31.816	445.384
2013	-4	481.2		31.816	31.816	445.384
2014	-4	481.2		31.816	31.816	445.384

IRR	30.90544
BCR	3.71

Table 12.6 Economic Cash Flow, Kurigram South Lower Confidence Interval

(Constant economic values, 1991 prices,million Taka

Year	Fish Losses (Tk)	Agricultural Benefits 1/	Capital Costs	O&M Costs	Total Costs	Net Economic Benefits
1974			4.9		4.9	-4.9
1975			4.9		4.9	-4.9
1976	0	0	4.9		4.9	-4.9
1977	0	0	4.9		4.9	-4.9
1978	0	0	4.9		4.9	-4.9
1979	0	0	10.9	0	10.9	-10.9
1980	0	0	10.9	0	10.9	-10.9
1981	0	0	10.9	0	10.9	-10.9
1982	0	0	10.9	0	10.9	-10.9
1983	0	0	10.9	0	10.9	-10.9
1984	-4	3.81	10.9	0	10.9	-11.09
1985	-4	3.81	10.9	30.4466	41.3466	-41.5366
1986	-4	8.3	10.9	30.463	41.363	-37.063
1987	-4	8.3	10.9	34.5958	45.4958	-41.1958
1988	-4	19	72.9	31.816	104.716	-89.716
1989	-4	19	59.3	31.816	91.116	-76.116
1990	-4	34.3	238.3	31.816	270.116	-239.816
1991	-4	72.3		31.816	31.816	36.484
1992	-4	72.3		31.816	31.816	36.484
1993	-4	72.3		31.816	31.816	36.484
1994	-4	72.3		31.816	31.816	36.484
1995	-4	72.3		31.816	31.816	36.484
1996	-4	72.3		31.816	31.816	36.484
1997	-4	72.3		31.816	31.816	36.484
1998	-4	72.3		31.816	31.816	36.484
1999	-4	72.3		31.816	31.816	36.484
2000	-4	72.3		31.816	31.816	36.484
2001	-4	72.3		31.816	31.816	36.484
2002	-4	72.3		31.816	31.816	36.484
2003	-4	72.3		31.816	31.816	36.484
2004	-4	72.3		31.816	31.816	36.484
2005	-4	72.3		31.816	31.816	36.484
2006	-4	72.3		31.816	31.816	36.484
2007	-4	72.3		31.816	31.816	36.484
2008	-4	72.3		31.816	31.816	36.484
2009	-4	72.3		31.816	31.816	36.484
2010	-4	72.3		31.816	31.816	36.484
2011	-4	72.3		31.816	31.816	36.484
2012	-4	72.3		31.816	31.816	36.484
2013	-4	72.3		31.816	31.816	36.484
2014	-4	72.3		31.816	31.816	36.484

EIRR	2.418848
BCR	0.54

Sections 12.2 and 12.3 noted the uncertainties concerning Project costs and benefits to Boro cultivation respectively. Sensitivity analyses for alternative assumptions concerning these parameters were carried out and showed somewhat less sensitivity to these two factors than to yields. Based on monsoon paddy benefits only, but a shorter take-up period than in the base case, the EIRR falls to about 17 per cent. However, if only FDR construction and normal O&M costs are assumed to have been incurred since 1987 the EIRR rises by about 2.5 per cent in both all paddy and monsoon paddy based assessments. Against this the EIRR falls if higher construction costs are assumed during the early stage of the Project (if earthworks have not been fully accounted for in the revised PP). Even for a benefit stream based on monsoon paddy only and maximum likely embankment costs, the point estimate EIRR falls to around 12-13 per cent. Calculations for the upper and lower confidence intervals for these alternative assessments have not been made.

12.7 CONCLUSIONS

The great sensitivity of the EIRR is easily borne out by Table 12.7 for the PP based costs and all paddy benefits. Similar calculations can be made for alternative cost and benefit assumptions which further widen the range of EIRRs. This suggests that considerable caution and careful judgement must be exercised in evaluating large projects like Kurigram South, as even small yield variations, well within the confidence limits, can render the Project 'unviable', even though the point estimates of yields suggest otherwise.

Given the sensitivity of the economic calculations to yield estimates, and the uncertainty over Project costs the benefit-cost calculations should not be taken as a reliable guide to Project performance. However, the calculations form a base which might be improved upon by future feasibility studies and evaluations. The overall impression from the earlier chapters is of a Project which has brought some agricultural benefits, but which has been limited due to planning, design and O&M constraints related to erosion, breaches and drainage congestion.

Table 12.7 Range of EIRRs Under Alternative Assumptions

Run	EIRR (%)
Base Run (Point Estimates)	22
Sensitivity I (+5% for Control; -5% for Project)	11
Maximum Limit (Based on SEs)	31
Minimum Limit (Based on SEs)	2.4

Source: Based on PIE data, see Tables 12.4-12.6.

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ANNEXES

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ANNEX A

HYDROLOGICAL ANALYSIS

The following tables (Tables A.1-A.3) comprise annual maximum and minimum water levels for the years on record at three gauging stations adjacent to Kurigram South Project: Chilmari (Brahmaputra), Kurigram (Dharla) and Kaunia (Teesta). This data comes from the BWDB water level gauges.

Subsequently FAP 12 has carried out a probability analysis of the annual maxima (extreme values) using Gumbel's formula, and Tables A.4-A.6 present the results of this analysis for the same three stations respectively.

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Table A.1 Annual maximum water level records - Chilmari

River : Brahmaputra - Jamuna

Station : Chilmari (45/5)

Unit : m/PWD

Year	Maximum	Date
1960		
1961		
1962		
1963		
1964		
1965	23.34	23 Aug
1966	23.81	1 Sept
1967	23.97	12 July
1968	24.04	25 July
1969	23.69	24 July
1970	24.19	28 July
1971	24.08	27 July
1972	24.09	31 July
1973	23.88	8 Aug
1974	24.46	5 Aug
1975	23.78	28 July
1976	23.90	3 July
1977	24.11	30 Aug
1978	23.21	22 July
1979	-	
1980	24.25	18 Aug
1981	-	
1982	-	
1983	24.04	15 Sept.
1984	23.04	15 July
1985	23.92	29 July
1986		
1987		
1988		
1989		
1990		

Source: BWDB data

Table A.2 Annual maximum water level records - Kurigram

River : Dharla

Station : Kurigram (77)

Unit : m/PWD

Year	Maximum	Date
1960		
1961		
1962		
1963		
1964	26.700	3 Aug
1965	26.610	14 Aug
1966	26.350	25 Aug
1967	26.320	11 July
1968	26.525	6 Oct
1969	25.870	18 July
1970	26.275	26 July
1971		
1972	27.035	30 July
1973	26.195	8 Aug
1974	26.715	29 July
1975	26.515	28 July
1976	26.305	4 July
1977	26.182	30 Aug
1978	25.832	17 July
1979	26.365	26 July
1980	26.579	17 Aug
1981	26.520	29 July
1982	26.257	29 July
1983	26.574	15 Sept
1984	27.330	18 Sept
1985	26.695	29 July
1986		
1987		
1988		
1989		
1990		

Source: BWDB data

Table A.3 Annual maximum water level records - Kaunia

River : Teesta

Station : Kaunia (294)

Unit : m/PWD

Year	Maximum	Date
1960		
1961		
1962		
1963		
1964		
1965	29.41	14 Aug
1966	29.84	25 Aug
1967	29.53	9 July
1968	30.45	6 Oct
1969	29.42	16 July
1970	29.69	22 July
1971	-	-
1972	29.81	30 July
1973	29.92	17 Aug
1974	29.93	29 July
1975	30.02	28 July
1976	30.06	6 Aug
1977	30.14	15 Aug
1978	29.92	2 Aug
1979	30.12	30 July
1980	30.02	21 July
1981	30.16	5 July
1982	30.10	18 Sept
1983	30.12	6 July
1984	30.05	14 July
1985	30.02	28 July
1986	29.72	15 Sept
1987	30.40	12 Aug
1988	30.10	16 Jun
1989		
1990		

Source: BWDB data

Table A.4 Probability Analysis by Gumbel's Formula - Chilmari (45.5)

Year	Annual Flood level (X_i)	$X_i - \bar{x}$	$(X_i - \bar{x})^2$	$(X_i - \bar{x})^3$	Reduced Variate	Recurrence Interval	% Probability
74	24.46	0.53	0.28	0.15	2.83	16.88	5.92
80	24.25	0.32	0.10	0.03	1.93	6.89	14.52
70	24.19	0.26	0.07	0.02	1.67	5.33	18.77
77	24.11	0.18	0.03	0.01	1.33	3.79	26.41
72	24.09	0.16	0.02	0.00	1.25	3.48	28.76
71	24.08	0.15	0.02	0.00	1.20	3.33	30.02
84	24.04	0.11	0.01	0.00	1.03	2.81	35.61
68	24.04	0.11	0.01	0.00	1.03	2.81	35.61
83	24.04	0.11	0.01	0.00	1.03	2.81	35.61
67	23.97	0.04	0.00	0.00	0.73	2.08	48.01
85	23.92	-0.01	0.00	0.00	0.52	1.68	59.44
76	23.90	-0.03	0.00	0.00	0.43	1.54	64.74
73	23.88	-0.05	0.00	0.00	0.35	1.42	70.51
66	23.81	-0.12	0.02	0.00	0.05	1.05	95.08
75	23.78	-0.15	0.02	0.00	-0.08	0.93	108.07
69	23.69	-0.24	0.06	-0.01	-0.46	0.63	158.71
65	23.34	-0.59	0.35	-0.21	-1.96	0.14	707.43
78	23.21	-0.72	0.52	-0.38	-2.51	0.08	1232.44

Σx = 430.8, Variance = 1.53, Average (x) = 23.93, Standard Deviation = 0.30

Ret. per. (years)	level (m.)
T (100)	24.88
T (50)	24.71
T (20)	24.50
T (10)	24.34
T (5)	24.18
T (2)	23.96
T (1)	23.80

Source: Table A.1, Consultants' analysis

Table A.5 Probability Analysis by Gumbel's Formula - Kurigram (77)

Year	Annual Flood level (X_i)	$X_i-\bar{x}$	$(X_i-\bar{x})^2$	$(X_i-\bar{x})^3$	Reduced Variate	Recurrence Interval	% Probability
84	27.33	0.87	0.75	0.65	3.81	45.27	2.21
72	27.04	0.57	0.33	0.19	2.71	15.03	6.65
74	26.72	0.25	0.06	0.02	1.51	4.55	22.00
64	26.70	0.24	0.06	0.01	1.46	4.30	23.27
85	26.70	0.23	0.05	0.01	1.44	4.22	23.70
65	26.61	0.15	0.02	0.00	1.12	3.07	32.57
80	26.58	0.11	0.01	0.00	1.01	2.73	36.57
83	26.57	0.11	0.01	0.00	0.99	2.68	37.26
68	26.53	0.06	0.00	0.00	0.80	2.23	44.74
81	26.52	0.06	0.00	0.00	0.79	2.19	45.59
75	26.52	0.05	0.00	0.00	0.77	2.15	46.45
79	26.37	-0.10	0.01	0.00	0.21	1.23	81.36
66	26.35	-0.11	0.01	0.00	0.15	1.16	86.05
67	26.32	-0.14	0.02	0.00	0.04	1.04	96.26
76	26.31	-0.16	0.03	0.00	-0.02	0.98	101.81
70	26.28	-0.19	0.04	-0.01	-0.13	0.88	113.89
82	26.26	-0.21	0.04	-0.01	-0.20	0.82	121.81
73	26.20	-0.27	0.07	-0.02	-0.43	0.65	153.57
77	26.18	-0.28	0.08	-0.02	-0.48	0.62	161.22
69	25.87	-0.59	0.35	-0.21	-1.64	0.19	517.35
78	25.83	-0.63	0.40	-0.25	-1.79	0.17	596.29

Σx = 555.75, Variance = 2.36, Average (x) = 26.46, Standard Deviation = 0.34

Ret. per. (years)	level (m.)
T (100)	27.54
T (50)	27.36
T (20)	27.11
T (10)	26.93
T (5)	26.74
T (2)	26.50
T (1)	26.31

Source: Table A.1, Consultants' analysis

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Table A3.6 Probability Analysis by Gumbel's Formula - Kaunia (294)

Year	Annual Flood level (X_i)	$X_i-\bar{x}$	$(X_i-\bar{x})^2$	$(X_i-\bar{x})^3$	Reduced Variate	Recurrence Interval	% Probability
68	30.45	0.50	0.25	0.12	2.95	19.16	5.22
87	30.40	0.45	0.20	0.09	2.71	15.08	6.63
81	30.16	0.21	0.04	0.01	1.56	4.77	20.95
77	30.14	0.19	0.03	0.01	1.47	4.34	23.06
79	30.12	0.17	0.03	0.00	1.37	3.94	25.38
83	30.12	0.17	0.03	0.00	1.37	3.94	25.38
88	30.10	0.15	0.02	0.00	1.28	3.58	27.94
82	30.10	0.15	0.02	0.00	1.28	3.58	27.94
76	30.06	0.11	0.01	0.00	1.08	2.96	33.84
84	30.05	0.10	0.01	0.00	1.04	2.82	35.50
80	30.02	0.07	0.00	0.00	0.89	2.44	40.99
75	30.02	0.07	0.00	0.00	0.89	2.44	40.99
85	30.02	0.07	0.00	0.00	0.89	2.44	40.99
74	29.93	-0.02	0.00	0.00	0.46	1.58	63.10
73	29.92	-0.03	0.00	0.00	0.41	1.51	66.20
78	29.92	-0.03	0.00	0.00	0.41	1.51	66.20
66	29.84	-0.11	0.01	0.00	0.03	1.03	97.14
72	29.81	-0.14	0.02	0.00	-0.11	0.89	112.16
86	29.72	-0.23	0.05	-0.01	-0.55	0.58	172.65
70	29.69	-0.26	0.07	-0.02	-0.69	0.50	199.35
67	29.53	-0.42	0.18	-0.08	-1.46	0.23	429.23
69	29.42	-0.53	0.29	-0.15	-1.98	0.14	727.22
65	29.41	-0.54	0.30	-0.16	-2.03	0.13	762.93

Σx = 688.95, Variance = 1.58, Average (x) = 29.95, Standard Deviation = 0.27

Ret. per. (years)	level (m.)
T (100)	30.80
T (50)	30.65
T (20)	30.46
T (10)	30.31
T (5)	30.17
T (2)	29.98
T (1)	29.83

Source: Table A.1, Consultants' analysis

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