Government of the People's Republic of Bangladesh

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

BANGLADESH FLOOD ACTION PLAN

FAP 12
FCD/I AGRICULTURAL STUDY

PROJECT IMPACT EVALUATION OF ZILKAR HAOR PROJECT

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Hunting Technical Services Limited

in association with

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

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Zilkar Haor
Kolabashukhali Project

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

Zilkar Haor Project

Project Summary Sheet

Project Name	: Zilkar Haor Project
Project Type	: Flood Control, Drainage and Irrigation
Location	
FAP Region	: North-East
District	: Sylhet
Area (ha.)	: 5263 ha. (gross) 4238 ha. (cultivable)
Funding Agency	: EIP (Netherlands and Sweden)
Implementing Agency	: BWDB
Construction started	: FY 1983/84
Scheduled Completion	: FY
Actual Completion	: FY 1987/88
Original Cost Estimate	: Tk.
Final Cost Estimate	: Tk. 75.5 million (1991 prices)
Major Flood Damage:	: 1988
Repair/rehabilitation in	:

Overview:

A relatively small FCD project comprising both submersible embankment (Zilkar Haor) and full flood protection (Haparu Haor) sections, which was a development of existing water management systems and planned with local consultation. The Project has operational problems relating to sluice design and management, and Haparu Haor is subject to rainwater congestion when early rains coincide with high river stages. Nevertheless, agricultural impact has been strongly positive, through the greater security provided for Local Boro (Zilkar Haor) and HYV Boro and both Local and HYV Aman (Haparu Haor). Paddy yields are double those of the control area. Fishery disbenefits are small, and EIRR is estimated at 40 per cent.

ZILKAR HAOR PROJECT

SUMMARY OF FINDINGS

Location

The Zilkar Haor Project is located in Sylhet District in the FAP North-East Region, immediately north west of Sylhet town. The Project covers a gross area of 5263 ha. and comprises two separate haors, Haparu Haor to the east and Zilkar Haor to the west (see Figure B4.1). The Project is bounded on the south and west by the Surma river, on the north by the Singar Khal and on the east by the Sadi khal which links the Surma river and the Singar Khal.

The control area is to the east of Sylhet town, upstream on the Surma and located between the Surma and the Bara Haor, a large unembanked haor area with similar topography to the Project and which is subject to flash floods.

Project Objectives

The Project aimed to provide different levels of flood protection to the two haors. It aimed to provide full flood protection to Haparu haor, protecting the Boro crop from early floods (April-May) and the Aus and Aman crops from monsoon season floods. However it only aimed to protect the Zilkar Haor from early floods, by means of a submersible embankment. The approach was expected to facilitate the existing irrigation system, which involved transferring water stored in Haparu Haor to Zilkar Haor during the rabi season.

Project History

The Project was financed under EIP. The technical proposal was prepared by the Sylhet Division of BWDB and this was followed by a socio-economic feasibility study in 1983 and a baseline study in 1984. The Project was reviewed and endorsed by the 1983 EIP Advisory Mission.

During Project preparation BWDB approached the local people and despite some early confusion the local people became involved with and identified with the Project. There was consultation at the planning stage with respect to land acquisition, alignment of the embankment, construction of sluice gates and provision of irrigation pipe inlets.

Construction started in 1983/84 and was substantially complete by 1987/88. The entire area was severely affected by floods in 1988 and the area used as a control in the PIE survey was badly affected by an early flash flood in 1990.

Construction and Design

The Project involved construction of a 15.8 km. full flood embankment around Haparu haor and an 8.9 km. submersible embankment around part of Zilkar Haor. In addition 3 regulators, 5 pipe sluices, and 25 pipe inlets were constructed, and 3.5 km. of drainage channels were excavated. In general the engineering infrastructure works as planned, although the road that acts as the embankment on the south tends to overtop, and the

structures leak and are in need of repair and maintenance. The existing regulators are inadequate to cope with the drainage problems that emerge in the monsoon season.

Hydrological Impact

The Project has generally succeeded in its objective of protecting Zilkar Haor from early flash floods, and this has been reflected in a substantial expansion in irrigation and production of both LV and HYV Boro. The full flood protection of Haparu Haor has had more limited impact as the lower part of the haor still suffers from serious drainage congestion, but there has been a modest conversion of low land to medium low land. A greater proportion of the Project area is irrigated compared with the control area, and more mechanised irrigation is used, probably reflecting increased security from early floods.

Operation and Maintenance

The RRA found that 60 to 70 per cent of the embankment length was in poor condition, that fall-board grooves were damaged at most structures and that culverts on the Sylhet-Sunamganj road had been converted to control structures and were in need of repair and modification. There is no routine maintenance and operation procedures are inadequate - for example irrigation pipe inlets are not closed at the right time, and as a result pre-monsoon flood waters enter the Project area.

Operation of the regulators on the Singer Khal seems satisfactory but there is a great deal of dissatisfaction over the operation of the road sluices, which seem often to be under the control of locally influential individuals and are a source of conflicts between farmers and fishermen.

Agricultural Impact

The Project has had a substantial positive impact on agriculture. This was particularly evident in 1990, when the Boro crop was effectively protected in the Project area, and severely damaged in the control area outside the Project, but the differential is expected to be significant even in normal years. The Project has resulted in a very substantial increase in the cultivation of HYV Boro (quite important in the Project area, very little grown outside it) and a substantial increase in production of LV Boro. HYV Boro in Haparu Haor is, however, still at risk from rainwater congestion when, as observed in 1991, early heavy rains coincide with high river stages which prevent drainage.

Yields of all crop varieties appear to be higher in the Project area than in the unprotected area, presumably reflecting reduced flood losses, and very much higher use of fertiliser in the protected area. Overall the weighted average paddy yield in the protected area is double that in the unprotected control area.

Livestock Impact

There appears to have been a slight negative impact on the bovine livestock population, compared to the position outside the Project area, as numbers are lower, feed quality is poorer, feed costs are higher and net incomes from livestock are lower. The differences however are not great. Despite the decline in draught power availability in the Project area there is no absolute draught power constraint.

Comparison with the control area suggests that the Project area has seen an increase in goat and duck numbers, but a decline in the chicken population.

Fisheries Impact

There appears to have been a negative impact on capture fisheries in the haor areas, although this is not as marked as in other FCD projects. Even in the Zilkar Haor area, where flooding is delayed rather than prevented, there have been some reductions in the capture fishery. In Haparu Haor the full flood protection has promoted limited development of some of the beels by restocking with hatchery produced fish to compensate for the loss of natural stocks. There are very few fish ponds, due to the continuing danger of overtopping (especially in Zilkar Haor proper) and little prospect of any substantial development of pond culture. Fishermen ascribe the fall in fish yields to the embankments, which block fish migration, to the increased use of agrochemicals on crops, and to fish disease.

Infrastructure and Communications

The Project appears to have had a marginally positive impact on road communications, but a significant negative impact on navigation - boatmen were identified as the second most seriously disbenefited group, after fishermen, and have declined considerably in number.

The Project has provided some protection to housing and commercial infrastructure, but perhaps paradoxically the 1988 floods caused more damage to this infrastructure inside the protected area than outside. This may be because those inside the protected area had established buildings in areas that they believed were not at risk, whereas people outside the protected area tended to build on higher ground.

Socio-Economic Impact

The clear positive impact of the Project on paddy production appears to have had a significant impact on other economic activities. The protected area has a substantially higher level of employment in non-farm enterprises, particularly in rice milling and marketing and in vegetable trading, though there is little difference between Project and control areas in the incidence of non-farm secondary occupations.

Housing conditions are generally better in the protected area and there have been more land transactions. Notably, within the Project area some people have been able to substantially increase their holding sizes, whereas no-one interviewed in the control area has achieved this. It also appears that average loan sizes are higher within the protected area, and that those interviewed in the control area have significantly less access to credit. Adult literacy is much higher in the Project than in the control area, which is unlikely to be a Project effect but may explain some of the relative advances in the Project area.

The benefits of the Project clearly went to landowners, and in particular to larger landowners. This was confirmed both by RRA interviewees and by survey data, which showed that only those with over 1 acre of land (0.4 ha.) in the protected area had significantly higher per capita incomes than those outside the protected area. It was also noted that both inside and outside the Project households with relatively large holdings (particularly over 2.5 acres - 1.0 ha.) tended to receive a substantial proportion of their income from "salaries" - often remittances from overseas. This is likely to be a common phenomenon in the Sylhet District.

The Project's impact on women was difficult to identify, but women had more work in paddy processing and reduced work in net repair, thus being affected by the trade pursued by their husbands.

In five out of fourteen impacted mouzas doubts were expressed about the necessity of the Project. Three of these five expressed such doubts in terms of general dissatisfaction while in the other two there were feuds between rival factions.

The Project has clearly resulted in social tensions, particularly between farmers and fishermen, and between farmers and boatmen who used to earn their incomes from transport of boulders across the haors. It has also caused some dissatisfaction amongst those whose land was acquired for the embankments, as they were paid less than the prevailing land price. However, these were few in number, compared with other FCD projects studied by FAP 12.

Environmental Evaluation

Flood control has no direct impact on the relatively high south-western part of the Project area, but has significantly changed the physical environment elsewhere, especially in Haparu Haor. As a result, the Project has had a substantial positive impact on crop production, and hence on the economy as a whole. This has been offset to a limited extent by a reduction in capture fisheries and in navigation, and possibly in the bovine population. The hydrological data, and local opinion, suggests that there have been negative impacts on the immediately adjacent population, as there appears to have been a slight increase in flood depths outside the protected area.

Assessment of biotic impacts is difficult, given the complete lack of quantified baseline data. However, all ecological impacts in Bangladesh must be viewed in the context of the extreme pressure exerted by human population growth, and which would have continued regardless of Project intervention. The biotic impact of Zilkar Haor is therefore assessed as slight.

Economic Appraisal

Zilkar Haor is a fairly high cost Project (capital costs of Tk 15 000 per net benefited hectare), but has provided substantial economic benefits from increased agricultural production, without any significant quantifiable disbenefits. As a result it has a high Economic Internal Rate of Return (40 per cent) and a very satisfactory Benefit:Cost Ratio (3.4).

Recommendations

Operation and maintenance procedures need significant improvement at Zilkar Haor and a number of structures require repair or redesign. In particular regulator gates need to be sealed, the use of culverts on the main road as FCD structures needs to be reviewed and an additional drainage regulator is probably needed on Singhar Khal.

Tubewell development is negligible, although the Project location suggests that groundwater potential should be considerable. Given the large increase in land available for irrigation due to the Project, this potential, and the reasons for it remaining untapped, require investigation.

Ways of upgrading livestock production systems to compensate for the reduced grazing area should be examined.

The development of fish culture in ponds in the higher areas should be encouraged.

Given the generally beneficial physical and human environmental impacts of this small Project and the very limited biotic impacts, there appears to be no justification for detailed environmental audit.

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ABBREVIATIONS AND GLOSSARY

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

THE BENGALI CALENDAR

The Bengali calendar was used for interviewing because of its greater familiarity to most respondents, and some tabulations and figures are presented by Bengali months. The Bengali calendar is almost exactly half a month out of phase with the Gregorian calendar, the months starting on the 15th to 17th of the Gregorian months. The year starts on 1st Baishakh, 15 April.

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

1 INTRODUCTION

1.1 THE FAP 12 STUDY

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

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

Of the 17 projects for study, 5 have been assessed mainly by Project Impact Evaluation (PIE) methods, using a formal questionnaire approach and probability sampling. The remainder have been assessed by Rapid Rural Appraisal (RRA) methods, and RRA has also been used for preliminary reconnaissance of the 5 PIE projects. The present report describes the combined findings of the RRA and PIE of the Zilkar Haor Project.

1.2 PROJECT DESCRIPTION

1.2.1 Location

The Zilkar Haor Project is located in Sylhet Sadar Upazila, Kotwali Thana, falling under the BWDB's Sylhet Operation and Maintenance (O&M) Circle. The Project has a gross area of 5263 ha. and a net area of 4251 ha..

The Project area consists of two haors, the Zilkar Haor and the Haparu Haor, with the former being 1.8 metres or 6 feet lower than the latter. The two haors are divided by an embankment with irrigation inlets. The overall Project area is bounded by the Sylhet-Sunamganj highway which runs parallel to the Surma River and serves as an embankment. The northern boundary is formed by the Singer Khal (actually a river). The east is bounded by the Sadi Khal, while the west-northwest consists of a natural elevated levee of the Surma, which acts as a submersible embankment.

1.2.2 Physical Characteristics

The haors are roughly saucer-shaped, with the periphery somewhat elevated (ranging from 8 to 10 metres or 26 to 34' PWD) and the centres depressed and low-lying (usually 16'-20'). In general, the slope of the area is towards the Singer Khal in the north, with the eastern and southern peripheries being higher than the western section. As is to be expected, the homesteads are in the higher lands, concentrated around the periphery.

The pre-project flooding situation was characterised by early flash-floods in April-May, and gradual monsoon floods later on in July-August.

1.2.3 Outline of Project Design and Objectives

The Zilkar Haor Project is essentially a flood control project, with a very minor gravity irrigation component built into it. It was taken up for study as representative of a class of small, quick-yielding investments characterised by a submersible embankment. Part of the Project area (the Zilkar Haor) is protected by a submersible embankment, which imparts security to the Boro crop, particularly during its mature stage in April-May. The other part of the Project (the Haparu Haor), is protected by a full flood embankment, designed to safeguard the B. Aus and T. Aman crop. There are three regulators on the Singer Khal to facilitate drainage, and a number of bridges, culverts and gates on the Sunamganj-Sylhet highway, which acts as an embankment with structures.

1.2.4 Project History

The Zilkar Haor Project is part of the Early Implementation Project (EIP) programme, and was conceived and initiated by the BWDB. Its construction was begun in 1983/84 and completed in 1986/87. The Project successfully withstood the floods of 1987 and 1988, when the full flood embankment was neither breached nor topped, although there were aggravated drainage problems due to seepage of water through the regulators and accumulated rain water.

1.3 METHODOLOGY

1.3.1 Previous Evaluations

In selecting projects for PIE study, FAP 12 deliberately excluded those which have already been evaluated, thereby avoiding unnecessary duplication. No previous post-evaluations have been made on Zilkar Haor Project. However, a benchmark study was conducted in 1984 (see Ahmed, 1984). The villages/respondents selected for the benchmark study were not taken up for re-examination during the PIE as these were not selected by probability sampling.

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 (FAP 12 1991a) and the experience with its application in practice has been reviewed in the FAP 12 Final Report (FAP 12 1991b). Its main features are therefore only briefly summarised here.

FAP 12 has used two different but complementary approaches to project evaluation. These are Rapid Rural Appraisal (RRA) and Project Impact Evaluation (PIE). RRA is an informal survey technique intended to produce results more quickly than formal interview surveys, while avoiding biases in the data collected. It consists of selective direct observation and interviews conducted by a small team of well-qualified and experienced specialists who can reach informed judgements quickly in the field. Although some quantification of RRA results is possible, by its nature RRA is better at obtaining qualitative than quantitative data,

and it cannot (in contrast to probability sample surveys) provide statistical verification of the size and extent of observed impacts.

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

1.3.3 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.

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 landless labour households. Probability sampling was adopted in order to confer the ability to test for statistically significant differences between the impacted and control areas. The sample design was two-stage, to minimise logistical problems in compiling sample frames, the first stage consisting of mouzas (revenue villages) and the second of households. Selection of the first stage was with probability proportional to size (PPS) and of the second stage by simple random sampling, the PPS/SRS design being self-weighting.

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

The first-stage sample frames were taken from the Small Areas 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 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.

1.3.4 The RRA and PIE Surveys of ZHP

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

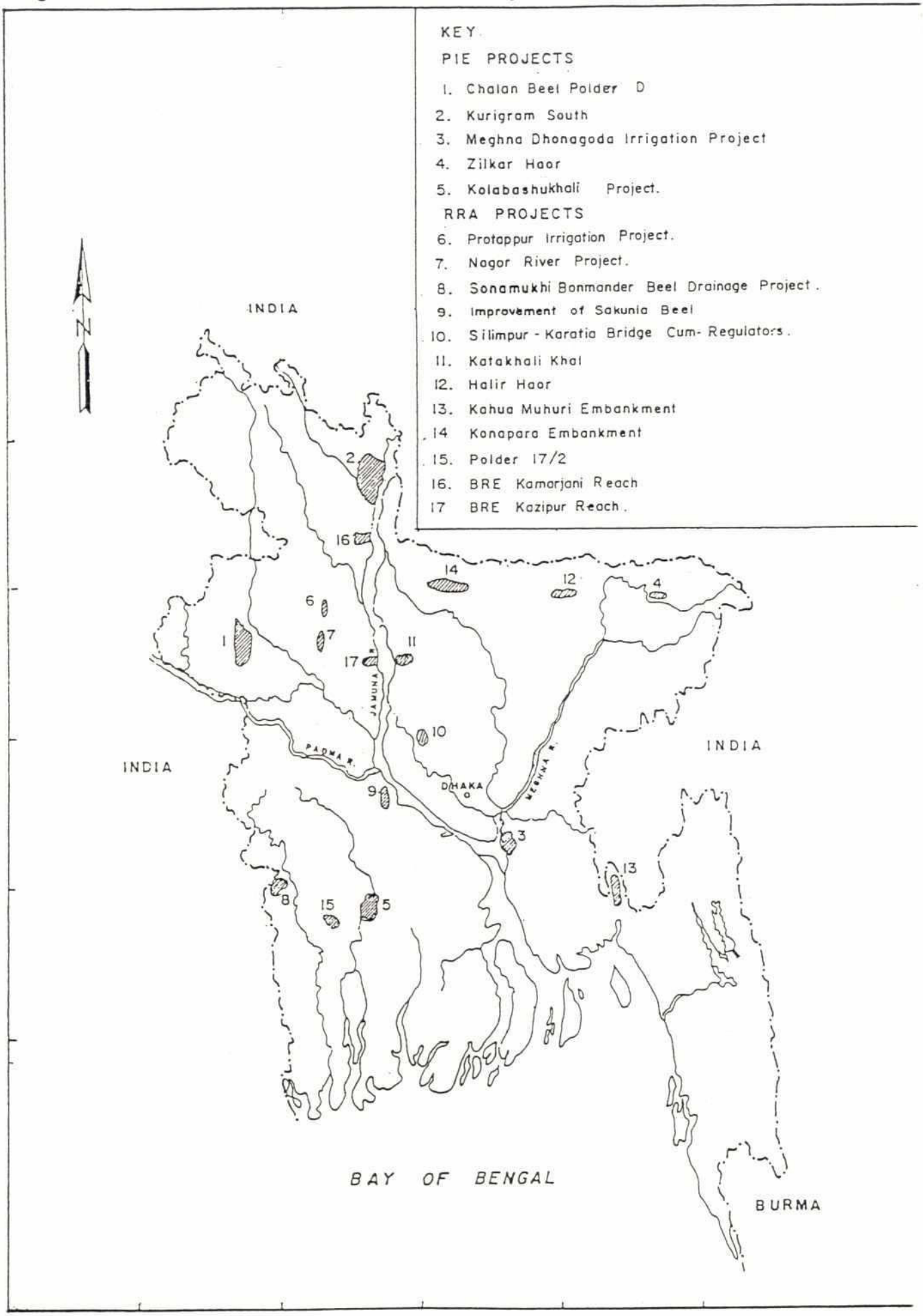
The PIE of ZHP was conducted in mid-1991, following the methodology described in Section 1.3.3 above. The control area selected for comparison with the Project area is on the north-east of ZHP, some 30 km. from the Project area (see Figure 1.3). This area is closely comparable with the Project area in distribution of land area by pre-Project flood depth, and its agricultural characteristics are very similar to those recorded for the ZHP area pre-Project by the baseline survey (Ahmed 1984).

In the impacted area a total of 120 cultivating and 48 labour households were sampled in 24 clusters, falling in 15 different mouzas, while 60 cultivating and 24 labour households, in 9 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 Sylhet 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 Superintending Engineer and staff of the BWDB Sylhet O&M Circle, to the Chairmen and Members of the Union Parishads in the survey areas, and to Friends in Village Development in Bangladesh. Last, but by no means least, FAP 12 wishes to thank the over 400 farmers, labourers, fishermen, fish traders and rural entrepreneurs, who with the women of their households gave their time and shared their experience with the study teams.

Figure 1.1 Locations of Selected PIE and RRA Projects



Source: Consultants

Figure 1.2 Zilkar Haor - Impacted Area

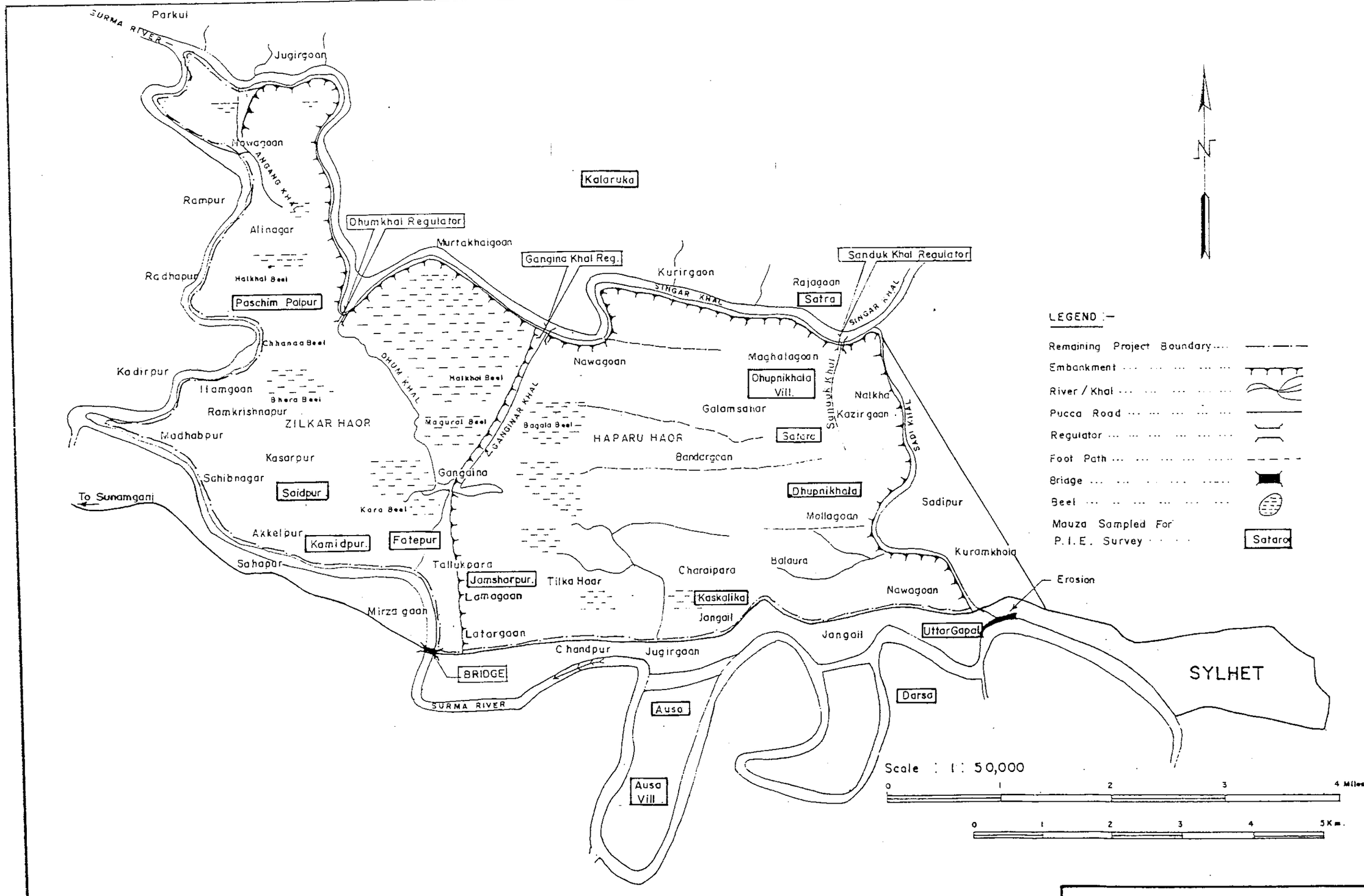
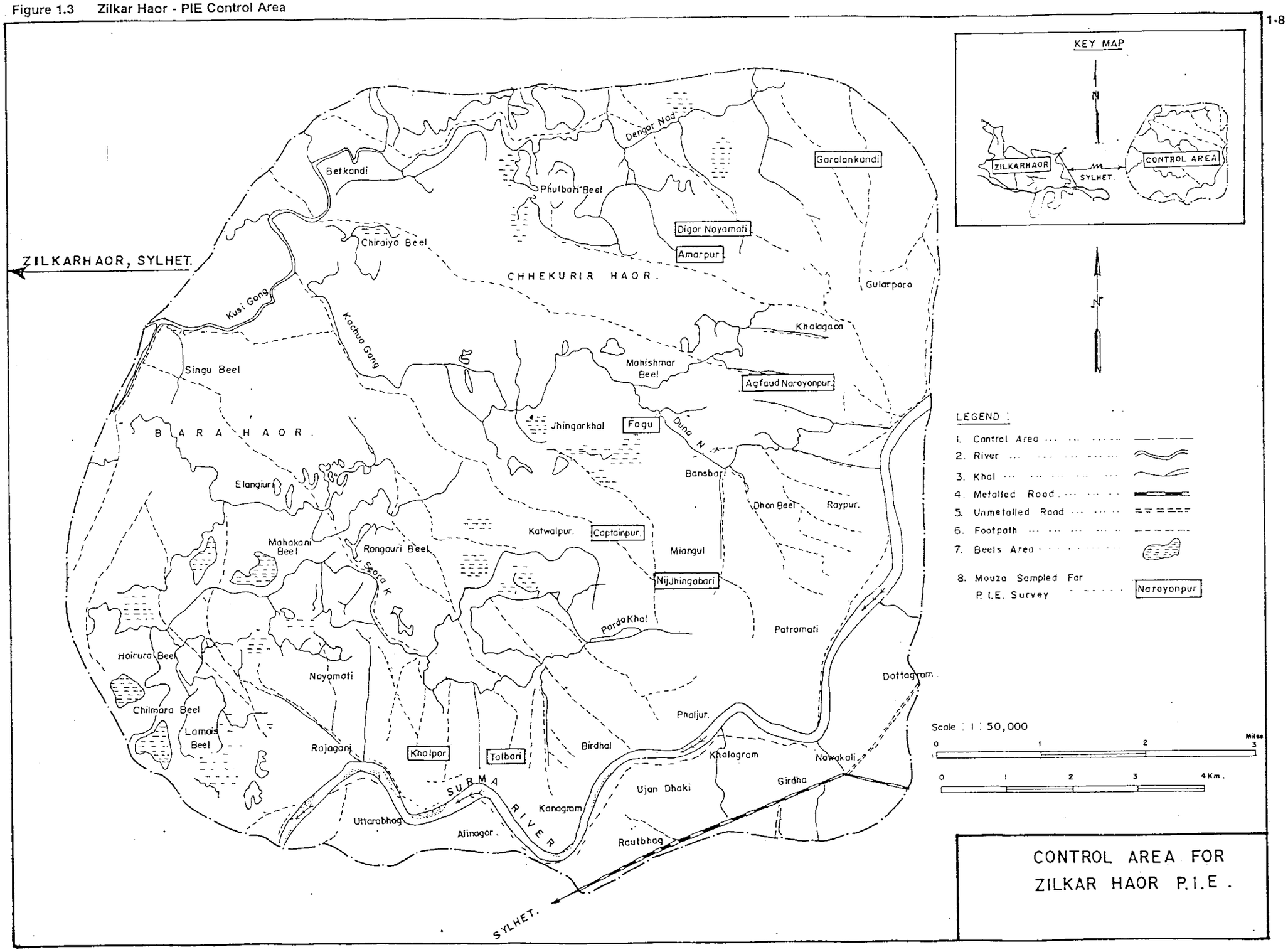


Figure 1.3 Zilkar Haor - PIE Control Area



2 ENGINEERING AND HYDROLOGY

2.1 PRE-PROJECT SITUATION

2.1.1 Flood Type and Agricultural Problems

The Zilkar Haor Project is a typical case of Flood Type H characterised by an early inflow of flash floods followed by a prolonged period of very deep flooding (see FAP 12 Final Report, Volume I, sub-section 3.4.1).

The pre-monsoon flash floods frequently used to damage the Boro crop during April-May in both haors and the monsoon floods damaged the T. Aman crop during July-August mainly in Haparu Haor. The Zilkar haor area, being lower, had negligible T. Aman cultivation.

The Project area faced the above problems as there were no protective devices to stop the flood water from the Singer Khal and the Surma River into the haors.

2.1.2 Water level Analysis

The hydrology of the Project area is exemplified by the water level data at Sylhet (station 267) and Gangina Khal Regulator site, as shown in Table 2.1 and Figures 2.1 and 2.2. Probability analysis was carried out by employing water level records at Sylhet (267) as shown in Tables 2.2. The salient features are:

- the annual maximum water levels at Sylhet (267) during 22 years fall within the ranges of elevation of 10.39 m. PWD (1980) and 11.76 m. PWD (1966) (see Table 2.1);

- the early season floods in April and May are of short duration, with an extremely large and rapid rise and fall, typical of the flash-flood type;

- the 1-in-100 year flood is 12.40 metres PWD, while even the 1-in-10 year flood is 11.7 metres, implying that extremely high embankments, with correspondingly high land take and cost, would be required for full flood protection in the lower parts of the Project area.

2.2 PROJECT OBJECTIVES

The Project objectives were to provide protection from the flash floods in early monsoon/pre-monsoon months, and from monsoon floods later on in the season.

Pre-monsoon flash floods were planned to be controlled by the construction of a full flood embankment around Haparu Haor and a submersible embankment around Zilkar Haor. The full flood embankment, the drainage regulators/sluices and the drainage canals were expected to provide protection to T. Aman crops in Haparu Haor. The existing gravity irrigation system based on LLPs would be strengthened by constructing a number of pipe inlets in the embankments.

Table 2.1 **Annual Water Level Records**
River: Surma-Meghna, Station: Sylhet (267)
Unit: metres above PWD datum

Year	Maximum	Date
1959	11.750	18th June
1960	11.355	22nd July
1961	10.396	19th June
1962	-	-
1963	-	-
1964	11.215	4th August
1965	10.925	13th August
1966	11.765	11th June
1967	10.995	30th July
1968	11.005	14th July
1969	10.940	27th August
1970	11.235	25th July
1971	-	-
1972	11.535	22nd June
1973	11.245	1st July
1974	11.355	29th July
1975	11.400	28th July
1976	11.720	1st July
1977	10.915	29th July
1978	10.440	28th June
1979	10.781	4th July
1980	10.394	19th July
1981	11.140	31st July
1982	11.150	7th July
1983	11.320	26th August
1984		
1985		
1986		
1987		
1988		
1989		
1990		

Figure 2.1 Water Level Record (Zilkar Haor 1983)

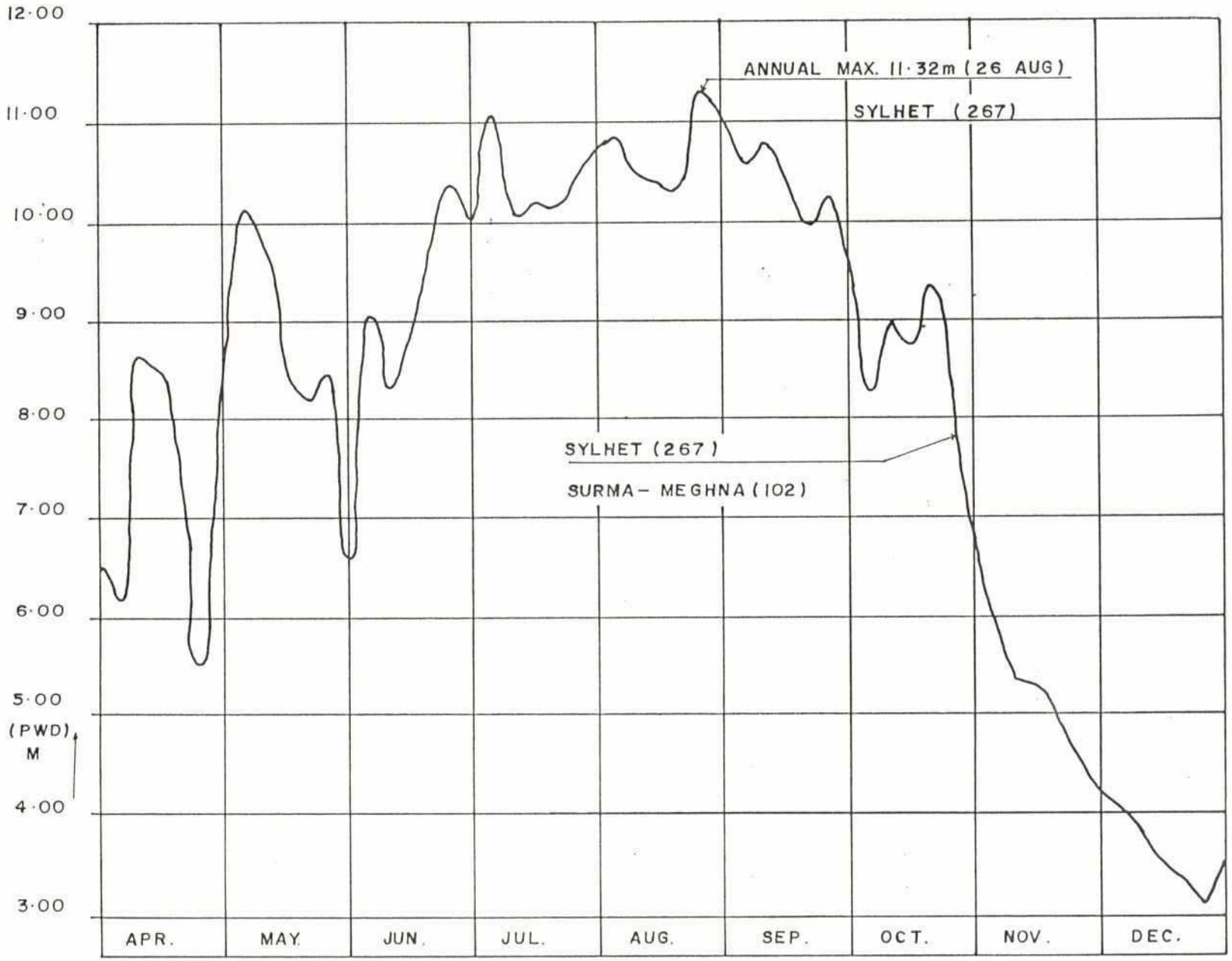


Figure 2.2 Water Level Record (Zilkar Haor 1990)

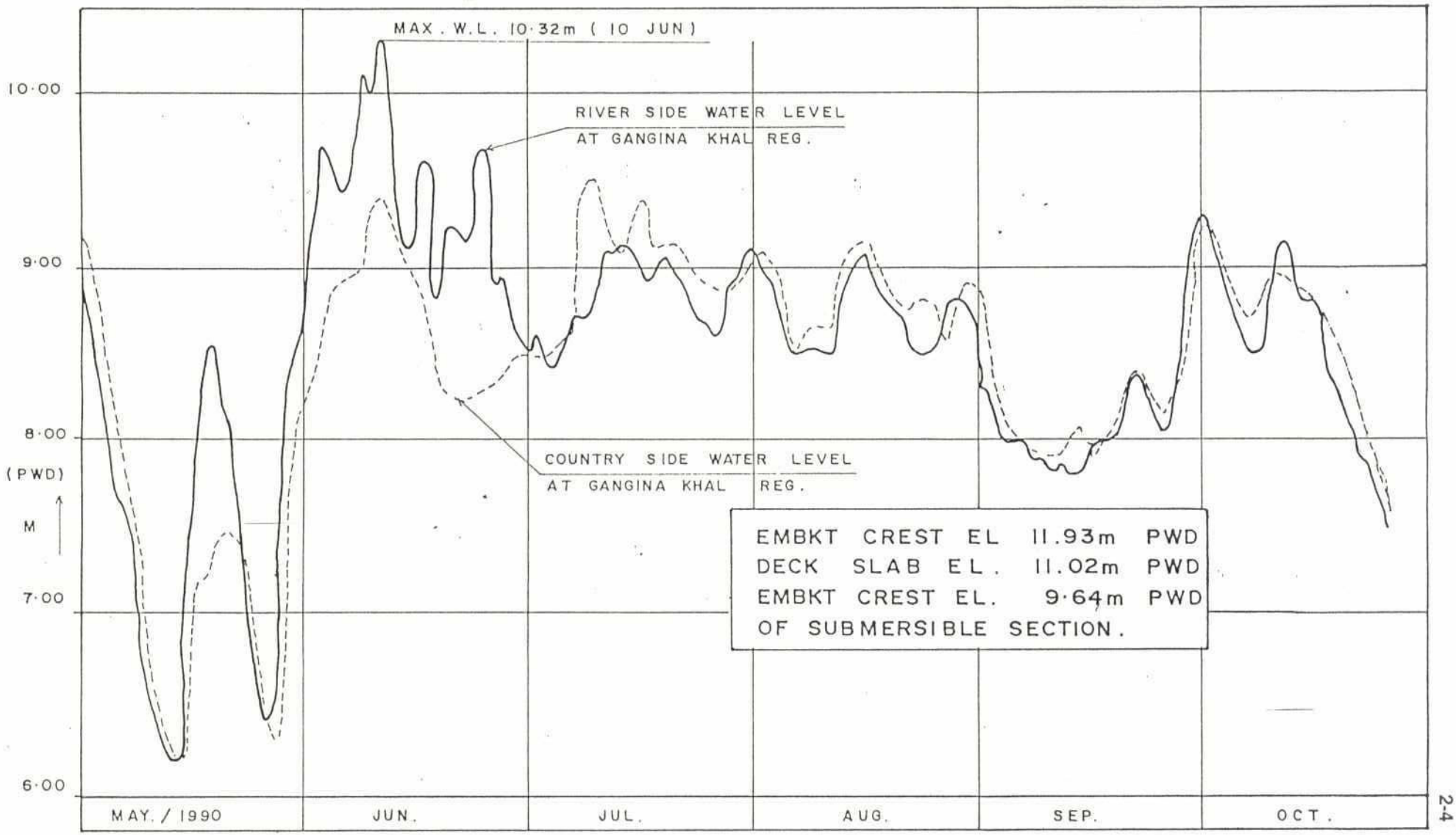


Table 2.2 Probability Analysis by Gumbel's Formula - Sylhet - (267)

Year	Annual Flood level (X_i)	$X_i-\bar{x}$	$(X_i-\bar{x})^2$	$(X_i-\bar{x})^3$	Reduced Variate	Recurre. Interval	% Probability
1966	11.77	0.63	0.40	0.25	2.59	13.34	7.50
1959	11.75	0.61	0.38	0.23	2.54	12.72	7.86
1976	11.72	0.58	0.34	0.20	2.45	11.55	8.66
1972	11.54	0.40	0.16	0.06	1.86	6.39	15.64
1975	11.40	0.26	0.07	0.02	1.42	4.15	24.08
1974	11.36	0.22	0.05	0.01	1.28	3.60	27.81
1960	11.36	0.22	0.05	0.01	1.28	3.60	27.81
1983	11.32	0.18	0.03	0.01	1.17	3.22	31.10
1973	11.25	0.11	0.01	0.00	0.93	2.53	39.53
1970	11.24	0.10	0.01	0.00	0.90	2.45	40.82
1964	11.22	0.08	0.01	0.00	0.83	2.30	43.51
1982	11.15	0.01	0.00	0.00	0.62	1.87	53.57
1981	11.14	0.00	0.00	0.00	0.59	1.81	55.31
1968	11.01	-0.13	0.02	0.00	0.16	1.17	85.17
1967	11.00	-0.14	0.02	0.00	0.13	1.14	87.93
1969	10.94	-0.20	0.04	-0.01	-0.05	0.95	104.84
1965	10.93	-0.21	0.04	-0.01	-0.10	0.91	110.00
1977	10.92	-0.22	0.05	-0.01	-0.13	0.88	113.57
1979	10.78	-0.35	0.13	-0.04	-0.56	0.57	174.33
1978	10.44	-0.70	0.48	-0.34	-1.65	0.19	518.74
1961	10.40	-0.74	0.55	-0.40	-1.79	0.17	597.11
1980	10.39	-0.74	0.55	-0.41	-1.79	0.17	600.94

Σx = 244.98, Variance = 3.38, Average (x) = 11.14, Standard Deviation = 0.40

T (100)	12.40
T (50)	12.18
T (20)	11.89
T (10)	11.68
T (5)	11.46
T (2)	11.17
T (1)	10.95

Source: Consultants

The intended targets were delaying onset of floods, reducing normal flood depths and prevention of peak floods. The submersible embankments around Zilkar Haor were intended to exclude floods until Boro paddy is harvested (target date for the harvest is 15th May) and then permit normal extreme flooding. The Haparu Haor area was intended to receive full flood protection against a 1-in-50 year event.

2.3 PROJECT STRUCTURES

The main design features of the Project are summarised in Table 2.3. The main features of the project are embankment, regulators, irrigation inlets, pipe sluices and drainage channels. The locations of the embankment, regulators and drainage channels are shown in Figure 1.1. The main project structures and their present condition are indicated in Table 2.4.

Table 2.3 Summary of Design Features

Embankment (Full Flood Protection)

Crest Elevation	:	11.93 m. PWD
Free Board	:	0.9 m.
High Water Level	:	11.03 m. PWD
Design Probability	:	1/50

Embankment (Submersible Section)

Crest Elevation	:	9.64 m. PWD
Free Board	:	0.90 m.
High Water Level	:	around 11.76 m. (variable)
Design Probability	:	1/20 ? (but limited to Boro season (mid-May))

Pipe Sluice	:	5 Nos.
Pipe Inlet	:	25 Nos.
Regulators/Box Culverts/Bridges	:	See Table 2.4

2.3.1 Embankment

The Project consists of both a full flood protection embankment and a submersible embankment.

The general condition of the embankment is comparatively better in Haparu Haor. In Haparu, the embankment is subjected to rain cut, numerous rat holes and wave action but Zilkar Haor embankment faces the problem of erosion due to overtopping and submersion every year.

Table 2.4 Summary of Condition of Main Existing Features of Zilkar Haor Project

	Present condition of structures									Present condition of Embankment		Present condition of Drainage channels
	Regulator/Sluice							Gate				
	No. of Vents	Type of Gate	Wing Wall C/S	Wing Wall R/S	Box	Apron C/S	Apron R/S	Gate	Rubber Seal/Grove	Full Flood Protection	Submersible	
Dhum Khal Regulator	2	FB							N/A			
Gangina Khal Regulator	3	VL	G	G	G	G	G	G	?			
*Sanduk Khal Regulator	2	FB	G	G	G	G	G	G	F			
*Box culvert at Jangail	1	FB	G	G	G	G	G	?	N/A			
*Box culvert at Jangail	1	FB	G	G	G	G	G	?	N/A	Total length 15.80 km. Top width 12 ft. for 12.3 km. and 8 ft. for 3.5 km. Side slope = 1:3	Total length 8.91 km. Top width = 8 ft. Side slope = 1:3	Main drainage channel = 1.5 km. Minor drainage channel = 2 km.
*Box culvert at Jangail	1	FB	G	G	G	G	G	?	N/A			The drainage channels need re-excavation
*Box culvert at Jangail	1	FB	G	G	G	G	G	?	N/A	50% of length needs repair	50% of length needs repair	
**Bridge at Chandpur	open											
**Bridge at Chandpur	open											
***Bridge at Latargaon	1	VL	G	G	G	G	G	G	?			
***Bridge at Latargaon	1	VL	G	G	G	G	G	G	?			

* RHD, Box Culvert on Sylhet- Sunamganj road functioning as water control structure for this project.

** RHD, Bridge on Sylhet- Sunamganj road without any water control provision possibly due to little or no impact on the project.

*** RHD, Bridge on Sylhet- Sunamganj road modified to water control structure by constructing one vent regulator box through the bridge opening and filling the gap by earth.

Gate type: FB = Fallboard VL = Vertical Lift
Condition: G = Good F = Faulty

The full flood embankment of Haparu Haor has two separate sections:

i. a length of 12.3 km. along the Singer Khal with a top width of 3.6 metres;

ii. a 3.5 km. long embankment dividing the Haparu and Zilkar Haors, with a top width of 2.4 metres.

The submersible embankment around Zilkar Haor also has a top width of 2.4 metres. The designed top widths do not exist any longer in major portions of the embankment but have been reduced by raincut and wave action. The side slope (s/s) for the entire embankment was designed at 1:3, but in major portions this is no longer available.

The Sylhet Sunamganj road acts as a flood protection embankment against floods from the Surma along the southern boundary of the project. To make it more effective, the existing culverts/bridges on this road have been modified and gated by BWDB to operate as water control structures (Table 2.4).

2.3.2 Regulators

Three regulators were constructed on the embankment of which 2 are in Haparu Haor and 1 in Zilkar Haor. Six culverts/bridges on Sylhet-Sunamganj road have been converted into water control structures (Table 2.4). Regulators/Control structures with fall boards (FB) were found to be leaking profusely and are very hard to operate under high head difference.

Fall-board grooves have been found to be damaged at most of the structures. The floor (apron) side slopes of the canals of Gangina Khal regulator have also been severely damaged. The flap gate of Sanduk Khal regulator needs proper maintenance. The culverts on Sylhet-sunamganj Road, which have been converted to water control structures within the project boundary, need repair and modifications to prevent seepage of flood water into the project area.

2.3.3 Pipe inlets/Pipe sluices

There are 25 pipe inlets in the embankment to facilitate irrigation from the rivers particularly from, Singar Khal. In addition 5 pipe sluices have been constructed, mostly on the embankment separating the Haparu from the Zilkar Haor. But the operation and maintenance of these small structures are not being carried out properly.

2.3.4 Drainage Channels

The drainage channels are very short. The main drainage channel is about 1.5 km. long and the length of the minor drainage channel is only about 2.0 km.. These channels need urgent re-excavation for proper functioning (Table 2.4).

2.3.5 Roads

There are practically no roads within the project area with the exception of minor village roads. The embankment now serves as the main road in the area. Bi-cycles are the main form of transport on the embankment. A small culvert on the Sadi Khal could connect the polder with the main R&H road.

2.4 PROJECT PERFORMANCE

2.4.1 Introduction

The Project objectives described in Section 2.2 have been broadly achieved in both the full flood protection part (Haparu Haor) and the submersible embankment part (Zilkar Haor) as originally designed. The full flood embankment in Haparu Haor was not breached or topped in the 1987 and 1988 floods. There was however, an aggravated drainage congestion problem here due to accumulated rain water and seepage/leakage of water into the area, through the gated culverts of the Sylhet-Sunamganj highway. Mean damage due to the 1988 floods per affected household in the protected area was about 3.7 times higher than in the control area (FAP 12 Final Report, Appendix M, Table M.21), but this reflects in part the greater wealth of the Project area due to the protection provided in normal years.

The Project impact due to FCD/I intervention is primarily a result of hydrological changes leading to differences in water conditions between pre- and post-project situations. These changes were assessed from the data collected in the PIE Household survey on the pre- and post-Project flood conditions on the land operated by a random sample of cultivating households. The results are discussed in Section 2.4.2 below.

2.4.2 Hydrological Impacts

a) Nature of the Data

The agricultural module of the PIE farm household survey collected information on flooding, drainage and irrigation status of the land cultivated by sample households, permitting 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 farm household survey covered a sample of 98.17 ha. of cultivated land in the impacted/protected area, 65.08 ha. in the impacted/unprotected area, and 79.92 ha. in the control area.

b) Impacts on Flood Depth and Duration

The areas of cultivated land under different flood depths in the pre-project and post-project situation are shown in Table 2.5 and Figure 2.3. Comparable data by inundation period are shown in Table 2.6 and Figure 2.4.

From Tables 2.5 and Figure 2.3, the Project impact on depth of flooding can be summarised as follows:

- the cultivated land area subject to shallow flooding (less than 30 cm.) has increased slightly from 7.0 per cent to 8.5 per cent of the total in the protected area. It decreased from 6.3 per cent to 4.8 per cent in the unprotected area, while no significant change was seen in the control area;

- on the other hand, the cultivated land area experiencing normal flooding of more than 90 cm. has decreased from 75.6 per cent to 65.5 per cent in the protected area, and increased from 69.0 per cent to 73.1 per cent in the unprotected area. The control area does not show any change;

Table 2.5 Cultivated Land by Flood Depth

(Unit: ha)

Flood Depth	Impacted Area						Control Area		
	Protected Area			Unprotected Area					
	Before	Present	Increase	Before	Present	Increase	Before	Present	Increase
High (%)	0.06 (0.1)	3.02 (3.1)	2.96 (3.0)	1.76 (2.7)	1.76 (2.7)	- (-)	- (-)	- (-)	- (-)
Medium High (%)	6.75 (6.9)	5.35 (5.4)	-1.40 (-1.5)	2.37 (3.6)	1.34 (2.1)	-1.03 (-1.5)	1.72 (2.1)	1.32 (1.7)	-0.40 (-0.4)
Medium Low (%)	17.14 (17.4)	25.53 (26.0)	8.39 (8.6)	16.05 (24.7)	14.40 (22.1)	-1.65 (-2.6)	20.06 (25.1)	19.10 (23.9)	-0.96 (-1.2)
Low (%)	40.22 (41.0)	33.04 (33.7)	-7.18 (-7.3)	18.09 (27.8)	21.36 (32.8)	3.27 (5.0)	31.31 (39.2)	29.65 (37.1)	-1.66 (-2.1)
Very Low (%)	34.00 (34.6)	31.23 (31.8)	-2.77 (-2.8)	26.81 (41.2)	26.22 (40.3)	-0.59 (-0.9)	26.83 (33.6)	29.85 (37.3)	3.02 (3.7)
Total (%)	98.17 (100.0)	98.17 (100.0)	- (-)	65.08 (100.0)	65.08 (100.0)	- (-)	79.92 (100.0)	79.92 (100.0)	- (-)

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

Source: Farm Household Survey

Table 2.6 Cultivated Land by Duration of Inundation

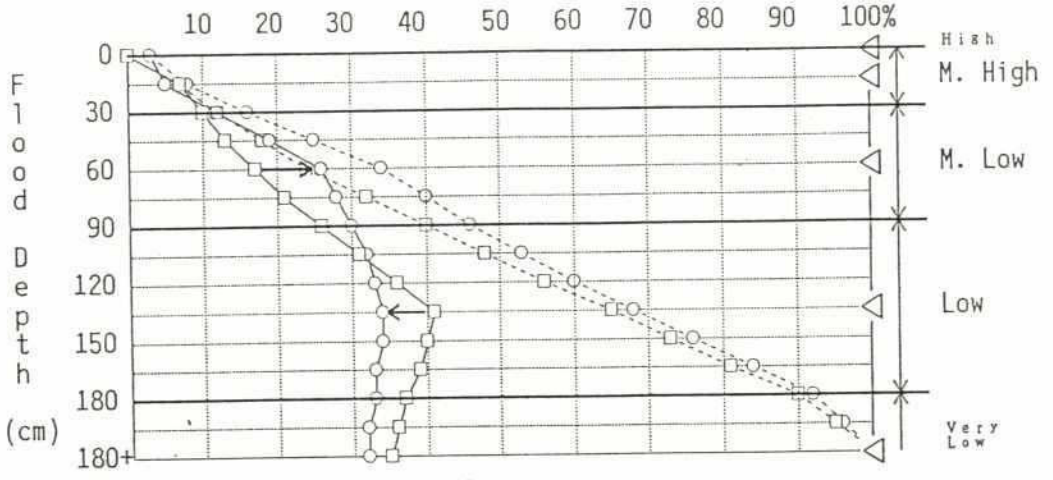
(Unit: ha)

Inundation Duaration (month)	Impacted Area						Control Area		
	Protected Area			Unprotected Area					
	Before	Present	Increase	Before	Present	Increase	Before	Present	Increase
0 (%)	0.49 (0.5)	3.70 (3.8)	3.21 (3.3)	2.04 (3.1)	1.56 (2.4)	-0.48 (-0.7)	1.01 (1.3)	- (-)	-1.01 (-1.3)
0 - 1 (%)	6.76 (6.9)	9.84 (10.0)	3.08 (3.1)	7.45 (11.4)	7.81 (12.0)	0.36 (0.6)	3.05 (3.8)	3.10 (3.9)	0.05 (0.1)
1 - 2 (%)	5.57 (5.7)	10.63 (10.8)	5.06 (5.1)	4.43 (6.8)	5.99 (9.2)	1.56 (2.4)	4.80 (6.0)	9.82 (12.3)	5.02 (6.3)
2 - 3 (%)	22.85 (23.3)	23.53 (24.0)	0.68 (0.7)	10.47 (16.1)	12.40 (19.1)	1.93 (3.0)	11.76 (14.7)	12.64 (15.8)	0.88 (1.1)
3 - 4 (%)	15.46 (15.7)	10.40 (10.6)	-5.06 (-5.1)	12.74 (19.6)	11.74 (18.0)	-1.00 (-1.6)	20.68 (25.9)	19.13 (23.9)	-1.55 (-2.0)
4 - 5 (%)	20.00 (20.4)	20.62 (21.0)	0.62 (0.6)	14.03 (21.6)	16.27 (25.0)	2.24 (3.4)	19.33 (24.2)	17.18 (21.5)	-2.15 (-2.7)
5 - 6 (%)	17.24 (17.5)	15.06 (15.3)	-2.18 (-2.2)	11.13 (17.1)	7.25 (11.1)	-3.88 (-6.0)	15.90 (19.9)	14.80 (18.5)	-1.10 (-1.4)
6 and over (%)	9.80 (10.0)	4.39 (4.5)	-5.41 (-5.5)	2.79 (4.3)	2.06 (3.2)	-0.73 (-1.1)	3.39 (4.2)	3.25 (4.1)	-0.14 (-0.1)
Total (%)	98.17 (100.0)	98.17 (100.0)	- (-)	65.08 (100.0)	65.08 (100.0)	- (-)	79.92 (100.0)	79.92 (100.0)	- (-)

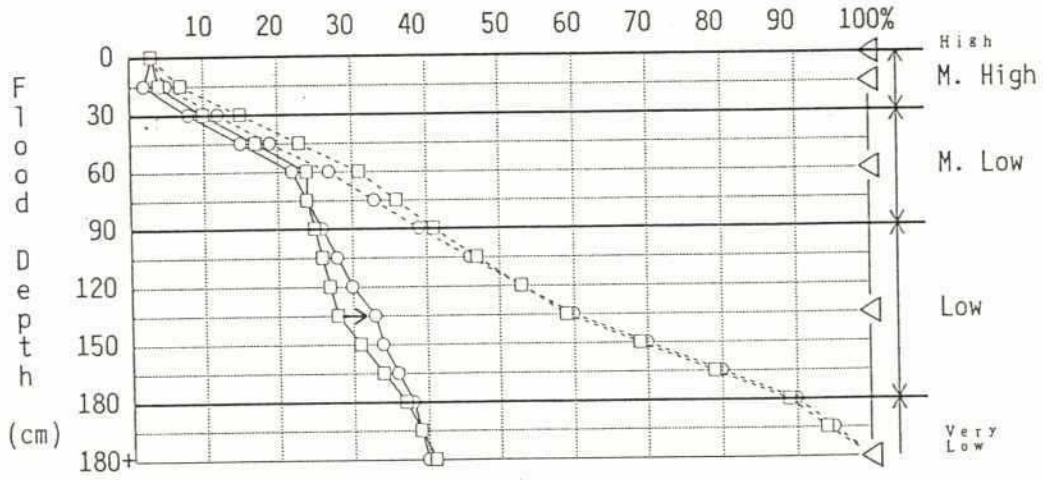
Source: Farm Household Survey

Figure 2.3 Cultivated Land by Flood Depth

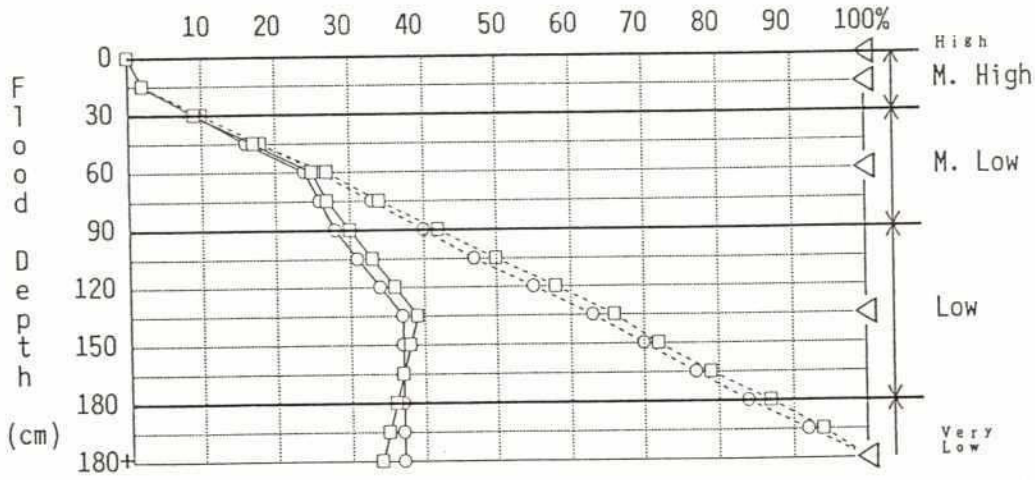
(1) Impacted Area - Protected



(2) Impacted Area - Unprotected



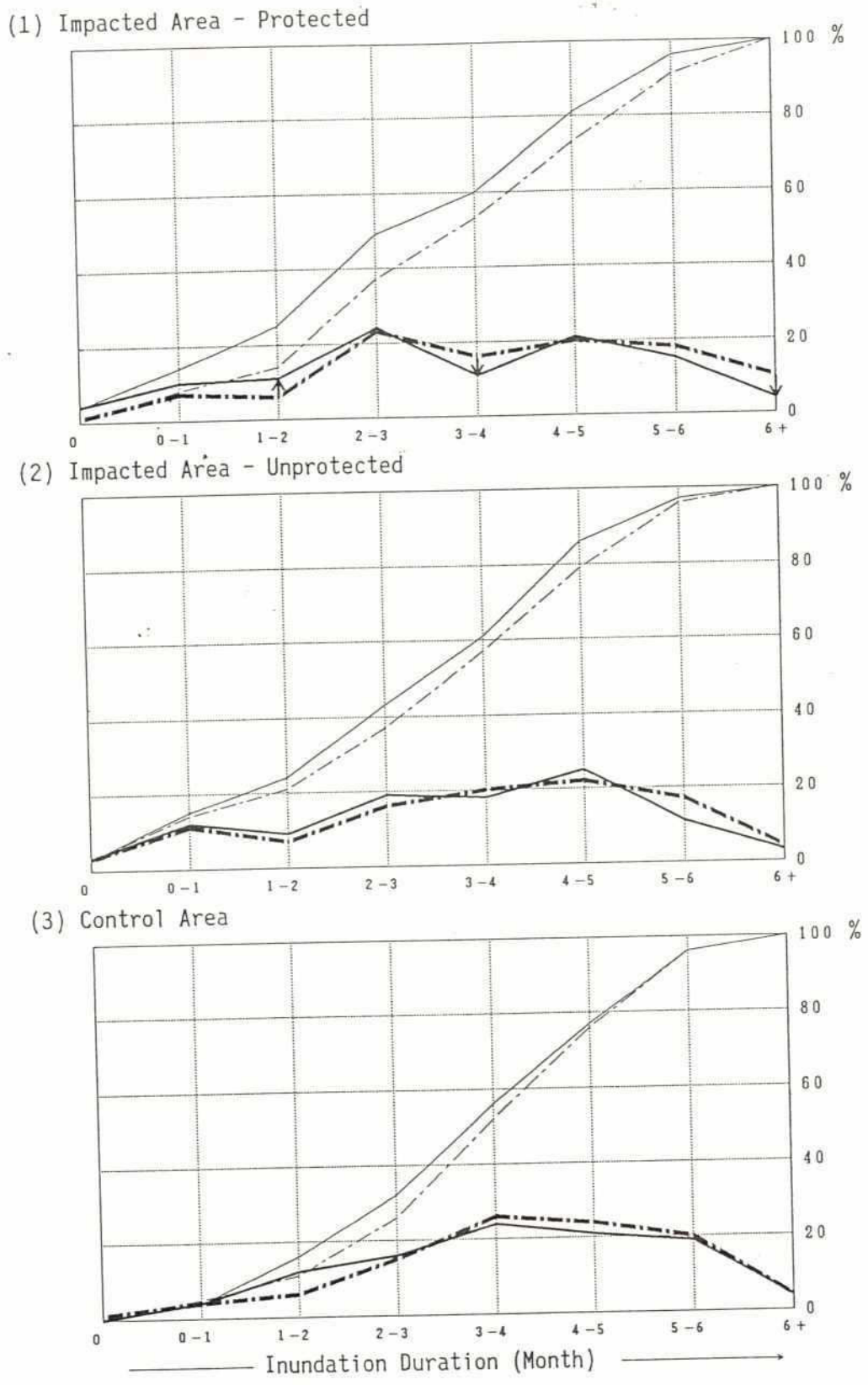
(3) Control Area



——— Actual Acreage (%) ····· Cumulative Acreage (%)

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

Figure 2.4 Cultivated Land by Inundation Duration



From Table 2.6 and Figure 2.4, the Project impact on duration of inundation comprises an increase in the proportion cultivated land in the Project area subject to a shorter inundation period (less than two months) from 13.1 per cent to 24.6 per cent, with a corresponding reduction in the area subject to a longer inundation period. The impacted/unprotected and the control areas show slight changes in this respect.

The above paragraphs show that the Project impact on flood depth and duration, while definitely present, does not appear to be large. The lack of impact on flood depth is not unexpected, since Zilkar Haor is partly a submersible embankment project which is not intended to protect the sub-area from normal floods. Haparu Haor, on the other hand, suffers from considerable drainage congestion and leakage of water into the area through the structures on Sylhet-Suhamganj highway. The congestion is to some extent unavoidable, since high rainfall tends to coincide with high river stages and gravity drainage is then impossible. Figure 2.2, which shows the 1990 water levels at the Gangina Khal regulator, clearly demonstrates the tendency of the external and internal water levels to fluctuate concurrently.

The small impact on inundation duration is not expected, given the project objective of delaying the rise of water level in order to safeguard the Boro harvest. However, the small apparent impact may be due to use in the PIE questionnaire of a monthly time division for specifying time of start and end of flooding. Zilkar Haor was the first PIE survey, and in subsequent PIEs the time division was amended to one week, to provide more precise measurement.

c) Impacts on Irrigation

The many beels in the project area retain water even after the flood waters have receded. These beels play a vital role in irrigating rabi season crops, especially HYV Boro and Local Boro, and a subsidiary objective of the Project was to facilitate this role. Tables 2.7 to 2.9 and Figure 2.5 give the post-project irrigation condition in the impacted and the control areas, based on which the following findings can be summarised:

- in the impacted/protected area 46 per cent of cultivated land is irrigated during the rabi season, compared 42 per cent in the impacted/unprotected area and to 13 per cent in the control area. Thus, while the impacted area clearly has a higher incidence of irrigation than the control area, this cannot be attributed to the project;

- in the impacted/protected area, 55 per cent of irrigated area is irrigated by indigenous methods, followed by LLPs (44 per cent). In the impacted/ unprotected area 67 per cent of irrigated area is covered by LLPs and the rest by indigenous methods. Most of the control area is irrigated by indigenous methods (86 per cent). Thus, DTW and STW are hardly operated in the Project areas that would indicate unavailability of groundwater in and adjacent to the Project area.

Table 2.7 Irrigated Area by Flood Depth and Crop Season

(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, T, LV	Crp. A.	-	0.06	0.91	2.35	0.20	3.52	-	-	1.21	2.91	0.85	4.97	-	-	1.25	0.37	-	1.62
	Irr. A.	-	0.06	-	1.25	0.20	1.51	-	-	0.24	-	-	0.24	-	-	-	-	-	-
	(%)	-	(100)	(-)	(53.2)	(100)	(42.9)	-	-	(19.8)	(-)	(-)	(4.8)	-	-	(-)	(-)	-	(-)
Aus, B	Crp. A.	-	-	1.75	0.16	-	1.91	0.08	0.24	0.79	0.12	-	1.23	-	0.59	9.23	4.32	1.55	15.69
	Irr. A.	-	-	-	-	-	-	-	-	0.24	-	-	0.24	-	-	-	0.17	-	0.17
	(%)	-	-	(-)	(-)	-	(-)	(-)	(-)	30.38	(-)	-	19.51	-	(-)	(-)	3.94	(-)	1.08
Aus, T, HYV	Crp. A.	-	0.61	0.30	1.03	0.24	2.18	-	-	0.48	0.20	0.36	1.04	-	0.34	-	-	-	0.34
	Irr. A.	-	-	-	0.73	-	0.73	-	-	-	-	-	-	-	-	-	-	-	-
	(%)	-	(-)	(-)	(70.9)	(-)	(33.5)	-	-	(-)	(-)	(-)	(-)	-	(-)	-	-	-	(-)
Aus, Total	Crp. A.	-	0.67	2.96	3.54	0.44	7.61	0.08	0.24	2.48	3.23	1.21	7.24	-	0.93	10.48	4.69	1.55	17.65
	Irr. A.	-	0.06	-	1.98	0.20	2.24	-	-	0.48	-	-	0.48	-	-	-	0.17	-	0.17
	(%)	-	(9.0)	(-)	(55.9)	(45.5)	(29.4)	(-)	(-)	19.35	(-)	(-)	6.63	-	(-)	(-)	3.62	(-)	0.96
Aman, B, LV	Crp. A.	-	2.91	-	1.94	-	4.85	0.24	-	0.73	0.24	1.94	3.15	-	-	3.70	10.70	15.60	30.00
	Irr. A.	-	2.17	-	1.46	-	3.63	-	-	-	-	-	-	-	-	0.24	1.05	0.12	1.41
	(%)	-	(74.6)	-	(75.3)	-	(74.9)	(-)	-	(-)	(-)	(-)	(-)	-	-	(6.5)	(9.8)	(0.8)	(4.7)
Aman, T, LV	Crp. A.	1.98	2.10	21.23	17.93	3.40	46.64	0.87	1.34	9.00	10.59	12.34	34.14	-	0.99	11.14	12.96	2.46	27.55
	Irr. A.	-	-	5.28	0.18	1.15	6.61	-	-	-	0.54	2.67	3.21	-	-	0.53	1.14	0.19	1.86
	(%)	(-)	(-)	(24.9)	(1.0)	(33.8)	(14.2)	(-)	(-)	(-)	(5.1)	(21.6)	(9.4)	-	(-)	(4.8)	(8.8)	(7.7)	(6.8)
Aman, T, HYV	Crp. A.	-	0.21	0.30	0.38	0.58	1.47	-	-	0.05	1.53	0.77	2.35	-	-	-	-	-	-
	Irr. A.	-	-	0.30	-	0.49	0.79	-	-	-	0.79	0.77	1.56	-	-	-	-	-	-
	(%)	-	(-)	(100)	(-)	(84.5)	(53.7)	-	-	(-)	(51.6)	(100)	(66.4)	-	-	-	-	-	-
Aman, Total	Crp. A.	1.98	5.22	21.53	20.25	3.98	52.96	1.11	1.34	9.78	12.36	15.05	39.64	-	0.99	14.84	23.66	18.06	57.55
	Irr. A.	-	2.17	5.58	1.64	1.64	11.03	-	-	-	1.33	3.44	4.77	-	-	0.77	2.19	0.31	3.27
	(%)	(-)	(41.6)	(25.9)	(8.1)	(41.2)	(20.8)	(-)	(-)	(-)	(10.8)	(22.9)	(12.0)	-	(-)	(5.2)	(9.3)	(1.7)	(5.7)
Boro, L	Crp. A.	-	0.49	0.95	7.44	20.65	29.53	-	-	0.48	4.49	5.65	10.62	-	0.40	0.13	3.63	12.71	16.87
	Irr. A.	-	0.16	0.86	5.76	17.87	24.65	-	-	0.48	4.25	4.79	9.52	-	0.40	-	0.87	7.72	8.99
	(%)	-	(32.7)	(90.5)	(77.4)	(86.5)	(83.5)	-	-	(100)	(94.7)	(84.8)	(89.6)	-	(100)	(-)	(24.0)	(60.7)	(53.3)
Boro, HYV	Crp. A.	1.94	0.55	5.62	6.96	5.87	20.94	1.23	1.09	3.10	7.61	5.99	19.02	-	-	1.01	-	0.28	1.29
	Irr. A.	1.82	0.55	5.62	6.47	5.80	20.26	1.15	1.09	2.97	7.48	5.22	17.91	-	-	1.01	-	0.28	1.29
	(%)	(93.8)	(100)	(100)	(93.0)	(98.8)	(96.8)	(93.5)	(100)	(95.8)	(98.3)	(87.2)	(94.2)	-	-	(100)	-	(100)	(100)
Rabi/Boro, Total	Crp. A.	1.94	1.04	6.57	14.40	26.52	50.47	1.23	1.09	3.58	12.10	11.64	29.64	-	0.40	1.14	3.63	12.99	18.16
	Irr. A.	1.82	0.71	6.48	12.23	23.67	44.91	1.15	1.09	3.45	11.73	10.01	27.43	-	0.40	1.01	0.87	8.00	10.28
	(%)	(93.8)	(68.3)	(98.6)	(84.9)	(89.3)	(89.0)	(93.5)	(100)	(96.4)	(96.9)	(86.0)	(92.5)	-	(100)	(88.6)	(24.0)	(61.6)	(56.6)
Grand Total	Crp. A.	3.92	6.93	31.06	38.19	30.94	111.04	2.42	2.67	15.84	27.69	27.90	76.52	-	2.32	26.46	31.98	32.60	93.36
	Irr. A.	1.82	2.94	12.06	15.85	25.51	58.18	1.15	1.09	3.93	13.06	13.45	32.68	-	0.40	1.78	3.23	8.31	13.72
	(%)	(46.4)	(42.4)	(38.8)	(41.5)	(82.5)	(52.4)	(47.5)	(40.8)	(24.8)	(47.2)	(48.2)	(42.7)	-	(17.2)	(6.7)	(10.1)	(25.5)	(14.7)

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 2.8 Irrigated Area by Depth and Means

(Unit: ha)

Season	Flood Depth	Impacted Area										Control Area				
		Protected Area					Unprotected Area									
		DTW	STW	LLP	Ind.	Total	DTW	STW	LLP	Ind.	Total	DTW	STW	LLP	Ind.	Total
Aus	High	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	M.H.	-	-	-	0.06	0.06	-	-	-	-	-	-	-	-	-	-
	M.L.	-	-	-	-	-	-	0.48	-	-	0.48	-	-	-	-	-
	Low	-	-	-	1.98	1.98	-	-	-	-	-	-	-	-	0.17	0.17
	V.L.	-	-	-	0.20	0.20	-	-	-	-	-	-	-	-	-	-
	Total	-	-	-	2.24	2.24	-	0.48	-	-	0.48	-	-	-	0.17	0.17
Aman	High	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	M.H.	-	-	-	2.17	2.17	-	-	-	-	-	-	-	-	-	-
	M.L.	-	0.42	5.16	-	5.58	-	-	-	-	-	-	-	-	0.77	0.77
	Low	-	-	-	1.64	1.64	-	-	0.61	0.72	1.33	-	-	-	2.19	2.19
	V.L.	-	-	0.49	1.15	1.64	-	-	0.77	2.67	3.44	-	-	-	0.31	0.31
	Total	-	0.42	5.65	4.96	11.03	-	-	1.38	3.39	4.77	-	-	-	3.27	3.27
Rabi/Boro	High	-	-	1.82	-	1.82	-	-	1.15	-	1.15	-	-	-	-	-
	M.H.	-	-	0.55	0.16	0.71	-	-	1.09	-	1.09	-	-	-	0.40	0.40
	M.L.	-	-	6.06	0.42	6.48	-	-	2.79	0.66	3.45	-	-	1.01	-	1.01
	Low	-	-	7.08	5.15	12.23	-	-	8.64	3.09	11.73	-	0.87	-	-	0.87
	V.L.	0.36	-	4.37	18.94	23.67	-	-	4.79	5.22	10.01	-	-	-	8.00	8.00
	Total	0.36	-	19.88	24.67	44.91	-	-	18.46	8.97	27.43	-	0.87	1.01	8.40	10.28
Total	High	-	-	1.82	-	1.82	-	-	1.15	-	1.15	-	-	-	-	-
	M.H.	-	-	0.55	2.39	2.94	-	-	1.09	-	1.09	-	-	-	0.40	0.40
	M.L.	-	0.42	11.22	0.42	12.06	-	0.48	2.79	0.66	3.93	-	-	1.01	0.77	1.78
	Low	-	-	7.08	8.77	15.85	-	-	9.25	3.81	13.06	-	0.87	-	2.36	3.23
	V.L.	0.36	-	4.86	20.29	25.51	-	-	5.56	7.89	13.45	-	-	-	8.31	8.31
	Total	0.36	0.42	25.53	31.87	58.18	-	0.48	19.84	12.36	32.68	-	0.87	1.01	11.84	13.72

Irrigation Means : DTW = Deep Tube Well, STW = Shallow Tube Well, LLP = Low Lift Pump, Ind. = Indigenous Ones
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 2.9 Irrigated Area by Means and Crop Season

(Unit: ha)

Crop		Impacted Area										Control Area				
		Protected Area					Unprotected Area									
		DTW	STW	LLP	Ind.	Total	DTW	STW	LLP	Ind.	Total	DTW	STW	LLP	Ind.	Total
Aus, T, LV	Irr. A.	-	-	-	1.51	1.51	-	-	0.24	-	0.24	-	-	-	-	-
	(%)	-	-	-	(100)	(100)	-	-	(100)	-	(100)	-	-	-	-	-
Aus, B	Irr. A.	-	-	-	-	-	-	-	0.24	-	0.24	-	-	-	0.17	0.17
	(%)	-	-	-	-	-	-	-	(100)	-	(100)	-	-	-	(100)	(100)
Aus, T, HYV	Irr. A.	-	-	-	0.73	0.73	-	-	-	-	-	-	-	-	-	-
	(%)	-	-	-	(100)	(100)	-	-	-	-	-	-	-	-	-	-
Aus, Total	Irr. A.	-	-	-	2.24	2.24	-	-	0.48	-	0.48	-	-	-	0.17	0.17
	(%)	-	-	-	(100)	(100)	-	-	(100)	-	(100)	-	-	-	(100)	(100)
Aman, B, LV	Irr. A.	-	-	-	3.63	3.63	-	-	-	-	-	-	-	-	1.41	1.41
	(%)	-	-	-	(100)	(100)	-	-	-	-	-	-	-	-	(100)	(100)
Aman, T, LV	Irr. A.	-	0.42	4.86	1.33	6.61	-	-	-	3.21	3.21	-	-	-	1.86	1.86
	(%)	-	(6.4)	(73.5)	(20.1)	(100)	-	-	-	(100)	(100)	-	-	-	(100)	(100)
Aman, T, HYV	Irr. A.	-	-	0.79	-	0.79	-	-	1.38	0.18	1.56	-	-	-	-	-
	(%)	-	-	(100)	-	(100)	-	-	(88.5)	(11.5)	(100)	-	-	-	-	-
Aman, Total	Irr. A.	-	0.42	5.65	4.96	11.03	-	-	1.38	3.39	4.77	-	-	-	3.27	3.27
	(%)	-	(3.8)	(51.2)	(45.0)	(100)	-	-	(28.9)	(71.1)	(100)	-	-	-	(100)	(100)
Boro, LV	Irr. A.	-	-	3.72	20.93	24.65	-	-	3.70	5.82	9.52	-	0.87	-	8.12	8.99
	(%)	-	-	(15.1)	(84.9)	(100)	-	-	(38.9)	(61.1)	(100)	-	(9.7)	-	(90.3)	(100)
Boro, HYV	Irr. A.	0.36	-	16.16	3.74	20.26	-	-	14.76	3.15	17.91	-	-	1.01	0.28	1.29
	(%)	(1.8)	-	(79.8)	(18.4)	(100)	-	-	(82.4)	(17.6)	(100)	-	-	(78.3)	(21.7)	(100)
Rabi/Boro, Total	Irr. A.	0.36	-	19.88	24.67	44.91	-	-	18.46	8.97	27.43	-	0.87	1.01	8.40	10.28
	(%)	(0.8)	-	(44.3)	(54.9)	(100)	-	-	(67.3)	(32.7)	(100)	-	(8.5)	(9.8)	(81.7)	(100)
Grand Total	Irr. A.	0.36	0.42	25.53	31.87	58.18	-	-	20.32	12.36	32.68	-	0.87	1.01	11.84	13.72
	(%)	(0.6)	(0.7)	(43.9)	(54.8)	(100)	-	-	(62.2)	(37.8)	(100)	-	(6.3)	(7.4)	(86.3)	(100)

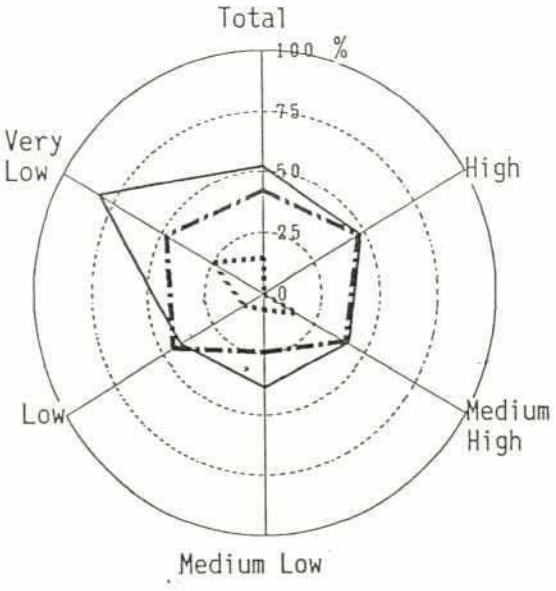
Irrigation Means: DTW = Deep Tube Well, STW = Shallow Tube Well, LLP = Low Lift Pump, Ind. = Indigenous Ones

Note: Irr. A. = Irrigated Area

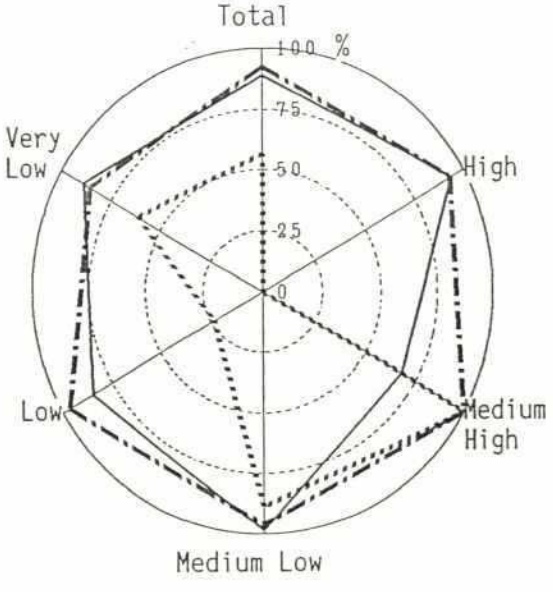
Source: PIE Farm Household Survey

Figure 2.5 Cropped Area under Irrigation by Flood Depth and Season

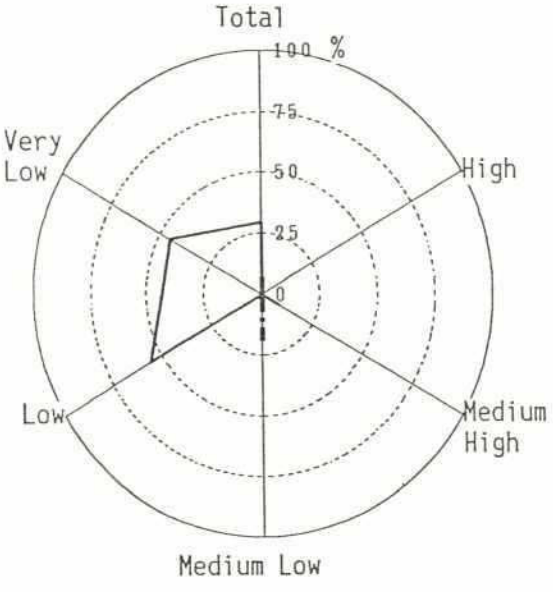
(1) Whole Season



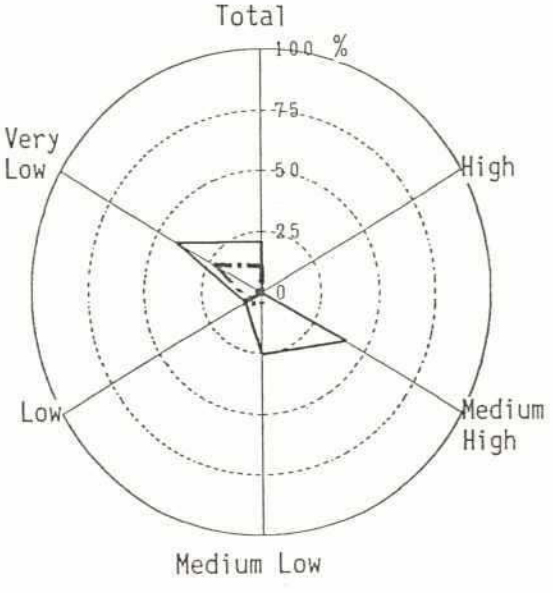
(2) Rabi/Boro Season



(3) Aus Season



(4) Aman Season



	Total Cropped Area (ha)				Legend
	Whole Sea.	Rabi/Boro	Aus	Aman	
Protected	111.04	50.47	7.61	52.96	———
Unprotected	76.52	29.64	7.24	39.64	-·-·-·-
Control	93.36	18.16	17.65	57.55	·····

2.4.3 Hydrological Comparability of the Control Area

To determine whether the control area does in fact constitute a valid hydrological comparison with the impacted area, the correlations were calculated for the pre-Project period in the impacted and control areas, on the percentage of area subject to stated flood depths and durations. The correlation coefficient (R) for flood depth is 0.97 (N = 5) and for inundation duration is 0.81 (N = 8). Despite the small number of degrees of freedom, the correlations are both highly significant, and that for flood depth is particularly impressive. Figure 2.3 gives visual confirmation of the striking similarity in the distribution of land by flood depth in the control area and in the pre-project impacted (protected) area. The analysis confirms the suitability of the control area for estimating project impact.

2.5 SUMMARY OF IMPACTS

2.5.1 Positive Impacts

i. The embankment, the regulators, sluices and pipe inlets are working broadly as planned. Pre-monsoon flash floods have been controlled in both the haors, and the HYV Boro crops have been protected as a result. Irrigation by LLP has been increased bringing more areas under Boro cultivation.

ii. The embankment has improved road communications in general.

iii. The full flood embankment has ensured T Aman production in higher reaches of Haparu Haor. Due to the confined water body in Haparu, fish cultivation has improved remarkably, with subsequent increase in revenue collection.

2.5.2 Negative Impacts

The Haparu Haor area suffers from acute drainage problems when high rainfall coincides with high river stages, preventing drainage (see hydrograph, Figure 2.2(2)). This causes damage to ripe HYV Boro in the premonsoon period, and to T. Aman in the lower areas during the full monsoon.

During the inspection of the structures at different locations on the embankment and on the Sylhet-Sunamganj Road (which works as a flood control embankment for the Project in the south) it appeared that there is a huge infiltration of water into the Haparu Haor during the high stages of the Surma river, through most of the structures. Local people complained that the fallboards of the pipe inlets and culverts are kept with the Union Parishad members and other influential people of the locality, who do not bother to put the fallboards in place on time. The flap-gate at Sanduk Khal regulator needs repair and all the regulators/sluices need timely operation to stop infiltration. The existing regulators seem to be inadequate to cope with the drainage problems caused due to infiltration and heavy rainfall during the monsoon.

2.6 RECOMMENDATIONS

Infiltration of flood water into the Project area must be stopped on a priority basis. To achieve this a series of actions need to be considered:

- all the culverts on Sylhet-Sunamganj road located within the Project area must be made as water tight as possible;

- two of the culverts which do not have gates should be suitably converted to act as water control structures;

- the timely placing of fall boards in pipe inlets and culverts should be ensured by forming active local committees involving BWDB staff, the beneficiaries, Union Parishad members and local influential persons. The activities of this LPC (Local Project Committee) should be monitored by BWDB staff;

- LPCs should also be formed to operate the regulators. If required a Khalashi should be posted at each regulator, with payment either by the beneficiaries or by BWDB;

- after the successful control of infiltration, the existing drainage facilities (drainage regulators and drainage canals) need to be evaluated to examine the capacity of the existing facilities, and in case of inadequacy, additional drainage facilities will have to be provided at an early date, to achieve the full planned objectives of the Project;

- in selecting the location for a new drainage regulator, a spot on the full flood embankment dividing Haparu and Zilkar Haor appears to be ideal. However, draining the water from one part of the Project to another might create serious social conflicts, and result in adverse effects on fisheries in Zilkar Haor. The drainage capacity of the Dhumkhal regulator should also be assessed properly with the changed situation. On the other hand, a new regulator near the existing 3 vent regulator at Nawgaon, with a drainage canal up to the Gangina Khal in Haparu Haor, appears to be a more attractive solution and will also avoid any adverse effects in the Zilkar Haor area;

- however, before taking any final decision about additional drainage regulators, the hydrology of the Singer Khal and the water level inside Haparu Haor must be studied thoroughly by establishing temporary gauge stations inside and outside the Project, to determine the available head difference for drainage. The gauge readings received from the XEN Sylhet BWDB Division for the months from May-Oct, 1990 (both for C/S & R/S) show discouraging figures for effective drainage of the Haparu Haor (see Fig-2.2(2));

- a culvert on Sadi Khal at Badaghat would provide road communication from the Zilkar Haor Project area to Sylhet town, and would fulfil a popular demand in the locality.

3 OPERATION AND MAINTENANCE - INSTITUTIONAL ASPECTS

3.1 PRE-PROJECT SITUATION

In many of the haors low embankments were initiated locally, often under the auspices of the local government authority. These were intended to raise the natural river levees in an attempt to provide greater security during the vulnerable period for early floods, just prior to the Boro harvest. In the Zilkar Haor area, however, no such initiatives were ever taken, prior to the BWDB investments. The beels within the haors are and were important fisheries resources, and this can bring conflicts between farmers who want rapid post-monsoon drainage and fishermen who wish to retain water. This is thought to have been a main reason for the lack of local FCD initiatives at Zilkar Haor.

An important aspect of the pre-operating stages of the Project that needs highlighting is the high level of participation of the local people in project implementation. BWDB approached and involved the local people much more than is usual in FCD/I projects, and, despite a lot of initial confusion, the people became involved with and identified with the Project. There was consultation between BWDB and local people at the planning stage with respect to land acquisition, alignment of the embankment, construction of sluice gates, and provision of pipe inlets for irrigation. This has not eliminated subsequent problems but is believed to have reduced them and to have helped the success of the Project.

3.2 INSTITUTIONAL FRAMEWORK

The Project is under the control of BWDB Sylhet O&M Division, and has the normal BWDB institutional framework. However, there is a lack of BWDB khalashis, and instead sluice operation is de facto in the hands of local influentials. Likewise the Project includes a number of irrigation inlets which are expected to be operated by farmers, but there appears to have been no attempt to encourage or require farmers to organise themselves to manage these structures effectively. Additionally, the submersible part of the embankment is regularly damaged during submersion, and hence the O&M of the Project is dependent on repairs carried out under food-for-work schemes. There is no local mobilisation of resources for maintenance, nor is there a recognised role for farmers in water management in the Project as a whole, while conflict resolution is in the hands of the local administration once it becomes serious.

3.3 OPERATION AND WATER MANAGEMENT

3.3.1 Technical Assessment

In general the embankment, regulators, sluices and pipe inlets are working as planned. The main problem is the attempt to give full flood protection and drainage to the Haparu Haor part of the Project, which faces acute drainage congestion during the main monsoon season causing damage to T Aman in the lower areas, and sometimes (as in 1991) also faces short-term congestion during premonsoon flash floods, which damage the ripe HYV Boro.

The structures in the embankment and the Sylhet-Sunamganj Road (which acts as a flood control embankment for the project in the south) leak and there is huge infiltration of

water into Haparu Haor during high stages of the Singer Khal and Surma river. These problems appear to arise from poor maintenance and from problems with the design of the structures. Local people complained that the fallboards of the pipe inlets and culverts are lying with the Union Parishad members and other influential people of the locality, and they do not take proper care to put these fallboards in place on time. The flap-gate at Sanduk Khal regulator needs repair, and all the regulators/sluices need timely operation to stop infiltration. Because of this infiltration, and heavy monsoon rainfall, the existing regulators seem to be inadequate to cope with drainage requirements (see Chapter 3 for examples of water levels inside and outside the Project).

If measures to prevent excess infiltration of water can be taken successfully (and this is likely to depend on coordinated participation by local people in plugging the gaps), then the existing drainage facilities (drainage regulators and drainage canals) need to be evaluated to examine the capacity of the existing facilities. In case of inadequacy, additional drainage facilities would need to be provided at an early date, to achieve the planned objectives of the Project.

3.3.2 Institutional and social assessment

There are reports of sharp conflicting interests, as before the Project, between fishermen/fish traders and farmers about the time of draining out water from the beels. However, the beneficiaries also seem to be aware of the rule of law, and to be optimistic about the visible positive benefits already created or to be created by the project. They did not cut the embankment nor break the sluice gates, even when there was serious drainage congestion in the project area during normal monsoon floods.

Likewise, the conflicts over leasing of beels and borrow pits still exist, but these are also resolved, mainly socially as before, through the intervention of local leaders, who are socially interlocked by kinship and marriage or business and political ties. Nevertheless, now that the potential benefits of these open access resources have increased, the intensity of such conflicts has also increased with a concomitant increase in the demand for legal interventions by the offices of BWDB, Deputy Commissioner, Land Revenue Department and police. For example, the conflicts between fish traders of Fatehpur and farmers of Dhumkhal over the opening and closing of Dhumkhal sluice gate in 1990 required the office of the Deputy Commissioner to issue strong notices about when to close and open the gate (which indicates the lack of ultimate power of the BWDB in determining acceptable operating principles).

The project has created additional open access resources. These include borrow-pits for fishing or for raising seedlings, and the embankment for shelter, cattle grazing and drying and storing of crops in the wet season. The leasing of borrow-pits has also been a source of modest revenue collection, amounting to about Tk 8000 annually. BWDB seems to have dealt with the leasing function satisfactorily, except that it had to cancel the lease one year because the highest bidder failed to deposit the full auction money within the stipulated time.

Irrigation pipe inlets are not closed on time, so that pre-monsoon flood water enters the project area. There are no formal inlet committees, nor were any explicitly mentioned in the project documents. BWDB should be more active in involving local beneficiary farmers in opening and closing the irrigation inlets in time. Specific responsibilities need to be assigned to specific groups of irrigation beneficiaries. Ultimately this depends on the farmers

themselves, but BWDB, Upazila officers and UP members could all play a part in encouraging farmers to organise specifically to undertake water management.

Alternatively, for operation and maintenance of the main structures, provision could be made for payment by farmers for the services of appointed persons such as khalashis or irrigation inlet gate keepers. For this, the possibility of collecting a share of incremental output from the beneficiaries by the sluice gate committees/irrigation inlet committees could be explored.

In pointing to the potential for farmer management of the structures, and hence for management of water, it should be remembered that local elites and landed households are still powerful, and the poor are dependent on them for their livelihood. The Socio-economic Baseline Survey of Zilkar Haor (Ahmed 1984) pointed out that "unless organized through institutional backing the local landed elites will never allow these people [the landless and marginal farmers] to take any share of benefits". Although FAP 12 could not produce conclusive evidence on changes in the dependence of the poor on landed elites, the landed elites sharecrop out more land to the poor and share input costs, especially in irrigated HYV Boro paddy production, and they also employ the landless and marginal farmers as wage labourers on their own cultivated land, and pay the harvest labour a fixed proportion of paddy output (distributional aspects are considered further in Chapter 8).

3.4 MAINTENANCE OF THE PROJECT

3.4.1 Technical Assessment

About 60-70 per cent of the embankment length was in bad shape prior to the 1991 monsoon. The top width has been reduced by wave action and rain cuts, severely damaging the side slopes and making the embankment weaker at several locations. Past maintenance seems to have been inadequate to maintain the embankment to its intended cross section.

Fallboard grooves have been found to be damaged at most of the structures. The floor (apron) and side slopes of the river side channel of the Gangina Khal regulator have also been severely damaged. The flap gate of Sanduk Khal regulator needs maintenance.

All the culverts on the Sylhet-Sunamganj Road where it serves as the project embankment, which have been converted to control structures within the project boundary, need repair and modifications to seal them against inflow of flood water into the project area. Local beneficiary participation and repairs to the structures are needed to make operation effective.

3.4.2 Institutional and Social Assessment

Resources for maintenance are a problem. Routine maintenance would be appropriate to the full flood protection embankments, but is not undertaken, while dependence on FFW for annual repair of the submersible embankment appears to be giving unsatisfactory results.

Possibilities for involving groups of landless men and women in the repair and maintenance of embankments, not just as wage labourers but also as work contractors through Labour Contracting Societies, should be explored (particularly as they could get work

annually doing repairs). The experience of NGOs, such as Friends In Village Development in Bangladesh, which is based in Sylhet, seemed encouraging in this respect.

3.5 LESSONS

Improved drainage operation requires better maintenance and design of structures: regulator gates need to be sealed and culverts closed properly. However, most of the problems are related to organisation and management. Fallboards for pipe sluices should be made available on time and put in place when needed. There are 25 pipe sluices so this requires coordination between inlet users. This is basically a social problem requiring proper management and community participation. Local project committees need to be geared up for the purpose.

Consultation during planning and implementation was better than is usual, and the Project satisfied an obvious need of the local farmers. Land acquisition created relatively few conflicts, and compensation was handled better than is usual. This appears, by and large, to have facilitated, the cooperation of local people in the closing and opening of sluice gates, although the sluice gate committees for Nawagaon and Dhumkhal are composed of members from influential large land owners and fisheries lease holders. The act of cooperation, or at least people's restraint from violent clashes, over disagreement about closing and opening of sluice gates, are positive lessons for the long term viability of any project.

Maintenance requirements will continue to be high since, wave action has considerably reduced the slope of the embankments, requiring resectioning of up to 50-60 per cent of the embankment each year. This is inevitable along the side of an open haor.

4 AGRICULTURE

4.1 INTRODUCTION

The Project area is approximately 5300 hectares, 80 per cent of which is cultivable land. This area is divided between two major haor areas - Haparu and Zilkar. High land comprised about 17 per cent of the Project area, which includes homesteads, roads and other settlements. Medium land was divided into two categories - medium high and medium low-land which comprised together 46 per cent of the area. Pre-Project local transplanted Aman was the main crop in this land category. Low land, where local Boro was the main crop, constituted about 37 per cent of the total.

The control area selected to represent the without Project situation was Bara Haor in Kanaighat Upazila of Sylhet district. The area is low lying, where Aman (43 per cent of area) was the main crop followed by Aus (23 per cent) (1983-84 Agriculture Census Report). Local broadcast varieties of Aman and Aus are still predominant.

The major pre-project problem of agriculture in Zilkar Haor was pre monsoon flash floods. As local Boro was the main crop in the low lying areas and as flash floods occurred frequently during the ripening and harvest stage, the probability of crop damage was high. Accumulation of water in the catchment area and overflow of water from the Haparu Haor caused severe damage to Boro crops. In Haparu Haor the problem was monsoon flooding, which mainly damaged the Aus and Aman crops. In the monsoon season both the Haors were deeply flooded by the high rainfall and inflow of water from the Surma and the Singer Khal.

The standing water in the fields during the sowing and transplanting period hampered timely cultivation of HYV and LV Boro. This in turn forced late harvest. Late harvested crops were more susceptible to pre-monsoon flash flood. Late sowing also hampered proper and timely application of farming practices which prevented shifting of varieties from LV to HYV and resulted in low yields.

In the Project area all the low lying areas were cultivated with Boro. Local varieties were predominant over high yielding varieties. Transplanted Aman covered about 55 per cent of the total cultivated area, and broadcast Aus covered about 8 per cent. Cropping intensity in the low and medium land areas was 100 per cent, and in the high land areas was 150 per cent; the average cropping intensity for the Project area was 117 per cent (Feasibility report 1983). The FAP 12 RRA estimated pre-project cropping intensity at 118 per cent.

The extent of crop damage in the pre-project situation was high for all the crops. In three consecutive years before the Project was implemented, the yield was very low because of flood damage. In those years per hectare yields of B. Aus, T. Aman, local Boro and HYV Boro were 0.59 tons, 0.64 tons, 0.37 and 0.0 tons respectively which was 60, 65, 81 and 100 per cent less than the normal yield. Irrigation facilities were scarce in the Project area, and only farmers having land near the surface water bodies were able to use irrigation. Irrigation was only by indigenous methods, by which only a small amount of land could be irrigated. That may be one of the reasons for the small extent of HYV Boro cultivation in the Project area in the pre-Project period.

4.2 PROJECT OBJECTIVES

The objectives of the Project were to prevent flash floods in Zilkar Haor, thereby facilitating HYV Boro cultivation and higher yields and in Haparu Haor, to prevent monsoon floods and to reduce drainage congestion which in turn would ensure Aman and Aus crops and permit increased cultivated areas.

The Project benefits in terms of expected impact on agriculture were:

- the Boro crop in the low-lying areas would be saved from pre monsoon flash flood since crops would be safe. The area under Boro would be increased in Zilkar Haor;
- if the monsoon season flooding was prevented, farmers would be able to cultivate transplanted Aus and Aman or Boro and Aman with irrigation on 1903 ha. of land;
- with the prevention of monsoon flood, damage to T. Aman would be decreased in Medium and High lands, and ultimately this area could be turned into a double cropped area, where T. Aus and T. Aman could be produced;
- if irrigation water were made available during the post monsoon and the dry seasons, high yielding varieties could be introduced in the high land, so that farmers would be able to produce a third crop (Boro and other Rabi crops);
- if flooding was prevented an incremental paddy production of 4054 mt. would be possible.

4.3 CROPS, CROPPING PATTERN AND CROPPING INTENSITY

4.3.1 Cropped area

Table 4.1 shows the use of cultivable land in different seasons. About half of the cultivable land remained fallow in both Boro and Aman seasons. In the impacted area, land use is highest in the very low land level in Boro season. This proportion of very low land used in the protected area is double the that in the control and unprotected areas. During the Aman season land in the high and medium land was most highly utilized in the protected area, but in the unprotected and control areas land at all levels was equally utilized. Total land use was highest in the control area during the Aman season. In the Aus season utilization of land was least in the protected and unprotected areas but in the control area it was almost three times greater. This is an expected result of the improved conditions for Boro cultivation in the protected area, since HYV Boro normally displaces Aus due to its higher profitability and the overlap of the Boro harvest with the Aus planting period.

The percentage of area cropped in Zilkar Haor has changed with the Project (Table 4.2). The submersible embankment in the Zilkar Haor has reduced the risk of flash flood damage to Boro crops. This encourages farmers to cultivate more Rabi season crops. Local Boro cultivation is more important than Boro HYV. Indigenous means of irrigation are predominant in the Project area as sinking of DTW or STW is technically troublesome or

impossible. According to local sources, the groundwater level is very deep and a hard gravel layer prevents drilling in the Zilkar Haor area.

The percentage of area under Boro HYV cultivation is 1.6 times more in the protected than in the control area, but is the same as in the impacted unprotected areas. The percentage of land under local Boro in the protected area is about 1.5 times more than that in the control and unprotected areas. This suggests expansion of Boro HYV in the Project area. The FAP 12 RRA found that the HYV Boro area post-project is four times more than in the pre-project situation, in broad agreement with the PIE findings.

Most of the local Boro is cultivated in the low-lying areas, both in the impacted and in the control areas, whereas HYV Boro is equally distributed in all levels. This may be because irrigation facilities are available at all levels of land.

Broadcast Aman cultivation is very low in the Project area in comparison to Transplanted Aman which occupies about 88 per cent of the total cultivated area in that season. In contrast, B. Aman occupies about the same percentage of area as transplanted Aman (Table 5.2) in the control area. HYV Aman is almost absent in the impacted and totally absent in the control area. However, the overall Aman area is higher in the control area.

Cultivation of Aus paddy in the Project area has declined (RRA report 1991). This agrees with the PIE data (Table 4.2) where it is evident that land under Aus cultivation in the control area is about 3 times greater than in the impacted area. The ratios of Boro to Aus area in the impacted and control areas are 6.5:1 and 1:1. This indicates increased use of land for Boro in the impacted area. As Boro maturity time and Aus planting time coincide, Aus cultivation after Boro in the same plot would be too late to avoid monsoon floods. As a result, B. Aus cultivation is important in the control area, but negligible in the impacted area.

The non-paddy crop area is negligible in both the impacted and control areas. Therefore, it may be concluded that Zilkar Haor Project is a paddy crop area where Boro is a predominant crop in Zilkar and Local Transplanted Aman is a predominant crop in the Haparu Haor.

4.3.2 Cropping Pattern

In the same crop field, Boro paddy (88.35 per cent) is followed by transplanted local Aman in the impacted area whereas transplanted Aman (72.63 per cent) follows broadcast Aus in the control area (Table 4.2). The sequence of HYV Boro and transplanted Aman occupies more land than the local Boro/T. Aman sequence (24.14 per cent). The same trend was observed in the unprotected adjacent area.

In general, the Boro HYV area has been extended and the B.Aman area has shifted to T. Aman due to the Project. The project has not encouraged diversified cropping in the Project area. Rabi crops other than Boro are negligible (0.13 per cent). This is a result of the relative returns to Boro and non-paddy crops, which favour Boro cultivation whenever there is sufficient irrigation water and flood security. The RRA estimated that about 3.5 per cent of rabi area was under non-paddy crops.

Table 4.1 Percentage Distribution of Cultivable Land by Crop Seasons and Crops

Area	Land Level[1]	Total Land Area (ha.)	Boro/Rabi Season[2]					Aman Season[2]				Aus Season[2]					
			Boro, LV	Boro, HYV	All paddy crops	Non-Paddy Crops[3]	All Crops	B.Aman, LV	T.Aman, LV	T.Aman, HYV	All paddy Crops	B.Aus, LV	T.Aus, LV	T.Aus, HYV	All Paddy Crops	Non-Paddy Crops[3]	All crops
Impacted Protected	HL	3.02	-	64.24	64.24	-	64.24	-	65.56	-	65.56	-	-	-	0.00	3.97	3.97
	MH	5.35	9.16	10.28	19.45	4.49	23.94	54.39	39.25	3.94	97.57	-	1.12	11.40	12.52	-	12.52
	ML	25.53	3.72	22.01	25.73	-	25.73	-	83.16	1.18	84.34	6.85	3.56	1.18	11.59	-	11.59
	LL	33.04	22.52	21.07	43.59	-	43.59	5.87	54.27	1.15	61.29	0.48	7.11	3.12	10.71	-	10.71
	VL	31.23	66.12	18.80	84.92	-	84.92	-	10.89	1.87	12.76	-	0.64	0.77	1.41	0.10	1.51
Total :	%	100.00	30.08	21.33	51.41	0.24	51.65	4.94	46.49	1.50	53.95	1.95	3.59	2.22	7.75	0.15	7.91
	ha.	98.17	29.53	20.94	50.47	0.24	50.71	4.85	46.64	1.47	52.96	1.91	3.52	2.18	7.61	0.15	7.76
Impacted Unprotected	HL	1.76	-	69.89	69.89	2.27	72.16	13.64	49.43	-	63.07	4.55	-	-	4.55	-	4.55
	MH	1.34	-	81.34	81.34	-	81.34	-	100.00	-	100	17.91	-	-	10.13	-	17.91
	ML	14.40	3.33	21.53	24.86	2.5	27.36	5.07	62.5	0.34	67.92	67.92	8.40	3.33	15.45	-	11.73
	LL	22.14	20.28	34.37	54.65	-	54.65	1.08	47.83	6.91	55.82	0.54	13.14	0.90	17.11	-	14.05
	VL	26.23	21.04	22.83	43.87	-	43.87	7.39	47.04	2.93	57.38	-	3.20	1.37	4.51	-	4.61
Total :	%	100.00	16.12	28.88	45.0	0.61	45.61	4.78	51.83	3.57	60.18	0.49	7.55	1.58	9.62	-	9.62
	ha.	65.87	10.62	19.02	29.64	0.40	30.04	3.15	34.14	2.35	39.64	0.32	4.97	1.04	6.33		6.33
Control	HL	-	-	-	0.00	-	-	-	-	-	-	-	-	-	0.00	-	-
	MH	1.72	23.26	-	23.26	-	23.26	-	57.58	-	57.58	34.30	-	19.77	54.07	-	54.07
	ML	19.10	0,68	5.29	5.97	-	5.97	19.37	58.32	-	77.69	48.33	6.54	-	54.87	-	54.87
	LL	29.65	12.24	-	12.24	-	12.24	36.09	43.71	-	79.80	14.57	1.25	-	15.82	-	15.82
	VL	29.45	43.16	0.95	44.11	-	44.11	52.97	8.35	-	61.32	5.26	-	-	5.26	-	5.26
Total :	%	100.00	21.11	1.61	22.72	-	22.72	37.54	34.47	-	72.01	19.63	2.03	0.43	22.09	-	22.09
	ha.	79.92	16.87	1.29	18.16	-	18.16	30.00	27.55	-	57.55	15.69	1.62	0.34	17.65	-	17.65

Source: FAP - 12 PIE Household Survey

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

2 Each boxes under each crop shows the percentage of the total land area cultivated under particular land level.

3 Non-paddy crops in the Rabi season include potato, chilli, and some winter vegetables while those in the Aus Season include only jute and some summer vegetables.

Table 4.2 Cropping Pattern
(% of gross cropped area)

Crops	Impacted												Control					
	Protected						Unprotected											
	HL	MH	ML	LL	VL	All Levels	HL	MH	ML	LL	VL	All Levels	HL	MH	ML	LL	VL	All Levels
B. Aus, LV	-	-	1.57	0.14	-	1.71	1.71	0.10	1.03	0.16	-	1.60	-	0.63	9.89	4.63	1.66	16.81
T. Aus, LV	-	0.05	0.82	2.11	0.18	3.16	3.16	-	1.57	3.78	1.10	6.45	-	-	1.34	0.40	-	1.74
1.74T. Aus, HYV	-	0.55	0.27	0.34	0.22	1.97	-	-	0.62	0.26	0.47	1.35	-	0.36	-	-	-	0.36
B. Aus, HYV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aus/Aman, Mixed	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
B. Aman, LV	-	2.62	-	1.74	-	4.36	0.31	-	0.95	0.31	2.53	4.10	-	-	3.96	11.46	16.71	32.13
T. Aman, LV	1.78	1.89	19.10	16.13	3.06	41.96	1.13	1.74	11.70	13.77	16.04	44.38	-	1.06	11.93	13.88	2.64	29.51
T. Aman, HYV	-	0.19	0.27	0.34	0.52	1.32	-	-	0.07	1.99	1.0	3.06	-	-	-	-	-	-
Boro LV	-	0.44	0.85	6.70	18.57	26.56	-	-	0.62	5.84	7.35	13.81	-	0.43	0.14	3.89	13.61	18.07
Boro HYV	1.74	0.50	5.05	6.26	5.28	18.83	1.60	1.42	4.03	9.89	7.79	24.73	-	-	1.08	-	0.30	1.38
Paddy Sub-total	99.88	100.00	100.00	100.00	99.98	99.87	99.95	100.00	99.53	100.00	100.00	99.48	0.00	100.00	100.00	100.00	100.00	100.00
Jute	-	-	-	-	0.02	0.02	-	-	-	-	-	-	-	-	-	-	-	-
Potato	-	-	-	-	-	-	-	-	0.47	-	-	0.47	-	-	-	-	-	-
Chilli	-	-	-	-	-	-	0.05	-	-	-	-	0.05	-	-	-	-	-	-
Vegetables	0.11	-	-	-	-	0.11	-	-	-	-	-	-	-	-	-	-	-	-
Total (%)	3.63	6.24	27.93	34.35	27.85	100.00	3.19	3.47	21.06	36.00	36.28	100.00	-	2.48	28.34	34.26	34.92	100.00
Gross Cropped Land	4.04	6.93	31.06	38.19	30.97	111.19	2.46	2.67	16.20	27.69	27.90	76.92	-	2.32	26.46	31.98	32.60	93.36

Source: FAP-12 Farm Household Survey

4.3.3 Incidence of HYV Paddy

HYV Boro is more extensively cultivated than HYV Aman and HYV Aus in the project area. Boro HYV occupies about 14 times more area in the impacted area than in the control area. HYV Aman occupies a very small area in both protected and unprotected areas, and is totally absent from the control area. The overall concentration of HYV paddy in the impacted area is much more than in the control area (Table 4.3). High yielding varieties grow better in the medium land in all the areas.

4.3.4 Cropping Intensity

There is no difference in cropping intensity due to the Zilkar Haor Project (Table 4.4). The area was single cropped before the Project with a cropping intensity of 117 per cent, and remains a single cropped area. In the protected area, two crops are sown on only 25 per cent of the gross cropped area whereas in the control area, double cropping is practised on 19 per cent of the gross cropped land. Triple cropping is virtually absent. Taking all levels together,the cropping intensity is almost the same in the protected and control areas.

4.4 CROP YIELDS

The average weighted yield of paddy (Table 4.5) is higher in the protected than in the control area for almost all the crops in all levels, except transplanted Aus which is a minor crop in the protected area. The overall paddy yield in the protected area is more than double that in the control area. However, there is a significant difference in yield of paddy in different land levels, where high lands produce more than low land. The increased yield indicates greater security against flood loss, and less fluctuation of flood levels in the Project area. Yield of B.Aman in both the areas is very low. T.Aman yield is moderate in the impacted area. Local Boro yield is also moderate. As the proportion of area under HYV Boro, local T. Aman and local Boro in the impacted area is higher than in the control area, the overall production is higher in the impacted area.

Table 4.3 HYV Paddy Concentration by Season

Crop Season	Impacted				Control	
	Protected		Unprotected			
	% of Cultivated Land in the Season	% of Gross Cropped Land	% of Cultivated Land in the Season	% of Gross Cropped Land	% Culvated Land in the Season	% of Gross Cropped Land
Aus	28.09	1.97	2.77	1.35	1.93	0.36
Aman	2.78	1.32	5.93	3.06	-	-
Boro	41.29	18.83	63.32	24.73	7.10	1.38
All season %	-	22.12	-	29.13	-	1.74
All season ha.	-	111.19	-	76.92	-	93.36

Source: FAP - 12 PIE Household Survey.

Table: 4.4 Cropping Intensity

Land Level	Land Area						Cropping Intensity		
	Total Cultivable Land (ha.)			Total Cropped Area (ha.)			Impacted		Control
	Impacted		Control	Impacted		Control			
	Protected	Unprotected		Protected	Unprotected		Protected	Unprotected	
HL	3.02	1.76	-	4.04	2.46	-	134	140	-
MH	5.35	1.34	1.72	6.93	2.67	2.32	130	199	135
ML	25.53	14.40	19.10	31.06	16.20	26.46	122	113	139
LL	33.04	22.14	29.65	38.19	27.69	31.98	116	125	108
VL	31.23	26.23	29.45	30.97	27.90	32.60	99	106	111
ALL Levels	98.17	65.87	79.92	111.19	76.92	93.36	113	117	117

Source: FAP - 12 PIE Household Survey

$$\textit{Cropping Intensity} = \frac{\textit{Total Cropped Area}}{\textit{Total Cultivable Land}} \times 100$$

Table 4.5 Per Hectare Yield of Paddy in Different Land Levels
(metric ton)

Paddy	Impacted												Control					
	Protected						Unprotected											
	HL	MH	ML	LL	VL	All levels	HL	MH	ML	LL	VL	All levels	HL	MH	ML	LL	VL	All levels
B. Aus, LV	-	-	1.75	1.80	-	1.75	2.3	0.62	2.60	1.84	-	2.11	-	1.53	1.26	1.36	1.28	1.30
T. Aus, LV	-	3.06	2.79	1.01	0.0	1.41	-	-	2.15	1.63	1.98	1.81	-	-	1.48	2.49	-	1.71
T. Aus, HYV	-	4.67	1.78	2.17	2.91	2.90	-	-	4.37	1.85	0.62	2.80	-	2.77	-	-	-	0.94
B. Aman, LV	-	1.04	-	0.59	-	0.86	0.76	-	1.78	0.59	0.44	0.83	-	-	1.08	0.59	0.59	0.65
T. Aman, LV	1.97	2.81	1.83	1.53	1.53	1.75	3.21	2.79	1.41	1.56	1.03	1.61	-	1.06	1.18	0.96	1.23	1.10
T. Aman, HYV	-	2.79	1.73	2.63	1.93	2.20	-	-	0.76	0.72	1.16	1.96	-	-	-	-	-	-
Boro, LV	-	2.95	1.8	2.57	1.33	1.68	-	-	3.06	2.07	1.75	1.75	-	1.38	1.38	1.09	1.16	1.15
Boro, HYV	5.16	6.15	4.22	3.53	2.69	3.70	6.4	6.15	3.88	3.28	2.94	3.67	-	-	3.93	-	1.58	3.43
Avg. Yield (Tons/ha.)	3.57	3.35	2.27	1.98	2.08	2.08	3.16	3.19	2.5	1.69	1.42	2.07	-	1.69	1.72	1.30	1.17	1.04

Source: FAP-12 PIE Household Survey.

The reference year for agricultural impacts in Zilkar Haor is Boro 1989/90 to Aman 1990. During that year, the Boro crop in the control area was heavily damaged by flash floods, possibly over-emphasising the yield superiority of the protected area. The FAP 12 PIE methodology recognised that damaging floods are not necessarily annual events, and the questionnaire obtained farmers' views on whether the survey year was "normal", and if not, what the "normal" yield would be. Twenty one per cent of protected area farmers classed the survey year as not "normal", compared with fifty per cent of protected area farmers, but even in a "normal" year (Table 4.6) mean paddy yield is 34 per cent higher in the control area than in the control area. Decreased yields were found in 70.5 per cent of the gross cropped area in the control site. The "normal year" yield difference was 0.62 metric tons per hectare, which clearly shows the impact of the Project.

Table 4.6 Crop Output in the Normal Year.

Crops	Protected			Control			Differences	
	Area (ha.)	Yield (mt./ha.)	Production (mt.)	Area (ha.)	Yield (mt./ha.)	Production (mt.)	Yield (mt./ha.)	Production (mt.)
B. Aus LV	1.66	1.75	2.91	7.38	1.65	12.21	+0.10	-9.30
T. Aus LV	1.76	1.59	2.80	0.37	2.5	0.93	-0.92	+1.87
T. Aus HYV	1.46	4.11	5.99	0.34	2.78	0.93	+1.33	+5.06
B. Aman LV	4.86	0.86	4.18	3.91	1.98	7.73	-1.12	-3.82
T. Aman LV	25.62	2.21	56.66	7.48	1.61	12.02	+0.60	+44.64
T. Aman HYV	1.45	2.17	3.15					
Boro LV	12.47	2.44	30.48	2.18	1.63	3.56	+0.81	+26.92
Boro HYV	7.75	4.32	33.48	1.01	3.87	3.92	+0.45	+29.56
All	57.03	2.44	139.65	22.67	1.82	41.30	0.62	94.93

Source: FAP - 12 PIE Household Survey

The reasons for higher yields are the reduced risk of flood, leading to a high percentage of land under HYVs (Table 4.3) and increased input use on the HYVs (Table 4.12).

4.5 CROP PRODUCTION AND OUTPUT

In Zilkar Haor Project, paddy is the major crop (4.2 above). The major indicator of Project impact will, therefore, be the change in paddy output. The RRA found that total paddy output in the Project area had increased by 64 per cent. The PIE data indicate that production has increased by 93 per cent (Table 4.7 and Table 4.8).

This increased production is the result of the decreased flood risk, increased HYV area and shifting from broadcast to transplanted varieties. As noted above, the HYV Boro area was much greater in the protected area than in the control area. The increase in Aman and Aus HYV area is not so significant. Although the B. Aman area is comparatively higher in the control area, the yield is very low, and it contributes less than T.Aman in the impacted area. Both Boro HYV and T. Aman have contributed a major share in the output change. Non-paddy output is insignificant in Zilkar Haor.

The crop output observed in the normal year in the protected area is about 41.6 per cent more than would have been achieved with control area normal year yields. Incremental crop output in a "normal" year would be around 3700 metric tonnes, whereas in the sample year (1990/91) it was over 4800 metric tonnes. As the "average" annual increment will include both normal and exceptional years the mean annual incremental output probably lies in the 3700 to 4800 mt. range. This results from higher harvested yields due to reduced flood losses in normal years, reduced flood losses in exceptional years, increased use of HYV varieties, a move from Broadcast to Transplanted varieties and increased use of inputs on crops. Output change in this Project has not been influenced by cropping intensity (see 4.4 above).

4.6 CROP PRODUCTION INPUTS

Due to greater security against flood damage, farmers in the impacted area have been adopting HYVs which are more productive than local varieties. This shift in cropping pattern has created a greater demand for more fertilizer, pesticide and irrigation inputs (Tables 4.9, 4.10, 4.11 and 4.12).

In the impacted area farmers are using about 9.5 times more fertilizer, and 13 times more pesticide and spending 7 times more on irrigation water than in the control area. However, the amount of seed and seedlings used is less in the impacted area as the farmers do not have to sow/transplant two or three times due to flood damage. Usually in the control area farmers sow/transplant several times when they lose the seedlings in the seed bed or in the field due to flood.

Human labour use is slightly lower in the impacted area than in the control area. This may be due to the higher use of mechanised irrigation which needs less labour. However, human labour costs still comprise about sixty per cent of the total expenses.

Animal labour cost is about 19 per cent less in the protected area than in the control area for all paddy crops. This is not because of lower animal labour use per unit area but because of the lower cost of animal labour in the Project area.

In the protected area, irrigation (Table 4.13) with indigenous methods is more popular than mechanical irrigation, but mechanical irrigation nevertheless is more widely practised in the protected area than in the control area. The only means of mechanical irrigation are low lift pumps, which is extensively used in the protected area. About 7 times more area is now under mechanised irrigation in the Boro season in the Project area than in the control area. The irrigated area in the Aus season is about 29 times more in the protected than in the control area. In this season only indigenous methods of irrigation are used.

The weighted average input cost for all the paddy crops is about 15.2 per cent more in the impacted area than in the control area. This is due to the increased use of fertiliser, pesticides and irrigation water, which are essential inputs for HYV cultivation. This again reflects Project success in reducing flood risks.

4.7 VALUE OF CROP OUTPUT AND NET RETURN

The aggregate net output value per hectare of crops in the Zilkar Haor protected area is more than double the value of the crops in the control area (Table 4.14). The net return is about ten times more than in the control area, the large disparity being due to the widespread crop failure in the control area during the survey year.

The aggregate net return per hectare of crop land was estimated at Tk. 7040 for the reference year in the impacted area, compared to Tk. 8868 in the normal year. On the other hand, per hectare returns in the control area were Tk. 660 in the reference year but Tk. 1136 in the normal year. The data shows that the returns from the impacted area are still about 8 times more than in the control area in normal years.

In terms of per hectare return to individual crops, the difference between protected and control areas is highest (Table 4.14) for broadcast Aus. Transplanted local Aman occupied the second position. The Boro HYV and T. Aman LV areas are high in the protected area and contribute a lot to the overall impact of the Project. The transplanted Aman area as well as the yield, are higher in the impacted area. As already noted, the negative returns to B. Aman LV and Boro LV in the control area, are due to the fact that 1990 was a severe flood year in the Sylhet area, when Zilkar Haor Project provided greater security to the crops. It should be noted that crop returns include the notional cost of family labour, costed at market wage rates; the negative returns therefore do not necessarily imply that farmers incurred an actual cash loss, but that family labour (which dominates input costs, even for HYVs) was poorly rewarded when yields were reduced. The net value was calculated on the basis of 1990 local prices.

4.8 PROJECT ACHIEVEMENT COMPARED TO TARGETS

The Project has achieved the target of expanded Boro HYV area in Zilkar Haor. The availability of irrigation water in the vicinity of the surface water bodies has facilitated Boro cultivation. There is increased Boro cultivation where previously T.Aus was cultivated. Local transplanted Aman area occupies a larger proportion of the area in the protected area than in the control, due to the decreased fluctuation in flood levels. However the Project is still mainly a single cropped area where Boro is the main crop in Zilkar Haor and T. Aman is the major crop in Haparu Haor. Considering all these points, it may be concluded that Zilkar Haor has been successful in achieving the expected agricultural benefits. Paddy production increased by 4806 metric tonnes, an improvement over the 4054 mt. which was targeted in the project proforma.

Table 4.7 Paddy Crops and Output in 1990-91

Paddy	Impacted							Control		
	Protected			Unprotected						
	Cultivated land area (ha.)	Total output (mt.)	Yield/ha. (mt.)	Cultivated land area (ha.)	Total output (mt.)	Yield/ha. (mt.)	All	Cultivated land area (ha.)	Total output (mt.)	Yield/ha. (mt.)
B. Aus, LV	1.91	3.34	1.75	1.23	2.60	2.11	1.90	15.69	20.40	1.30
T.Aus, LV	3.52	4.96	1.41	4.97	9.00	1.81	1.64	1.62	2.77	1.71
T.Aus, HYV	2.18	6.32	2.90	1.04	2.70	2.59	2.80	0.34	0.40	0.94
B.Aman, LV	4.85	4.17	0.86	3.15	2.46	0.78	0.83	30.00	19.50	0.65
T.Aman, LV	46.64	81.62	1.75	34.14	48.48	1.42	1.61	27.55	30.30	1.10
T.Aman, HYV	1.47	3.23	2.20	2.35	2.35	1.00	1.46	-	-	-
Boro, LV	29.53	46.61	1.68	10.62	20.60	1.94	1.75	16.87	19.40	1.15
Boro, HYV	20.94	77.48	3.70	19.02	69.23	3.64	3.67	1.29	4.42	3.43
All crops (Sample area)	111.04	230.73	2.08	76.52	157.42	2.06	2.07	93.36	97.19	1.04

Source: FAP - 12 PIE Household Survey

Table 4.8 Derivation of Incremental Paddy Production

		Protected Area Yield (mt./ha.)	Control Area Yield (mt./ha.)	Output (mt.)
Net Cultivable Impacted Area (ha.)	4240			
Impacted Area Cropping Intensity (%)	113			
Gross Cultivated Impacted Area (ha.) (at observed intensity)	4791	2.08		9966
Control Area Cropping Intensity (%)	117			
Gross Cultivated Impacted Area (ha.) (at Control Area itensity)	4961		1.04	5159
Incremental Paddy Production (mt.)				4806
Incremental Paddy Production (%)				93

Source: PIE Cultivator Sample Survey June 1991

Table 4.9 Proportion of Production Input Value by Inputs: Paddy Crops

Area Characteristics	Paddy	Seed/Seedlings (%)	Human Labour (%)	Animal Labour (%)	Fertilizer manure (%)	Pesticide (%)	Irrigation (%)	Total (Tk.)
Impacted Protected	B. Aus, LV	11.66	52.56	34.81	0.73	0.24	0.00	5378
	T. Aus, LV	8.20	54.95	29.43	5.86	0.69	0.83	11996
	T. Aus, HYV	4.87	55.90	23.94	12.80	2.49	0.00	12418
	B. Aman, LV	9.02	48.26	41.34	1.38	0.00	0.00	6829
	T. Aman, LV	9.23	49.75	35.31	4.08	1.63	0.00	8233
	T. Aman, HYV	11.23	51.25	27.46	10.05	0.00	0.00	11380
	Boro, LV	5.45	57.79	24.98	5.18	1.84	4.76	12077
	Boro, HYV	4.43	46.25	19.18	13.63	3.87	12.64	14175
	Avg.(weighted)	7.62	58.14	19.12	7.98	4.38	2.76	9336
Impacted Unprotected	B. Aus, LV	7.60	53.36	28.40	8.07	2.56	0.00	11403
	T. Aus, LV	5.67	60.59	27.52	2.00	1.10	1.09	9873
	T. Aus, HYV	3.46	54.67	24.53	12.78	4.59	0.00	18206
	B. Aman, LV	13.60	42.86	43.54	0.00	0.00	0.00	6052
	T. Aman, LV	7.36	58.39	30.12	3.11	1.02	0.00	9961
	T. Aman, HYV	9.77	53.56	25.81	8.51	2.35	0.00	11304
	Boro, LV	4.70	63.72	17.94	6.39	2.39	0.00	15066
	Boro, HYV	4.35	52.47	18.13	10.21	3.68	11.15	14910
	Avg.(weighted)	5.98	56.68	30.49	6.20	2.29	4.34	11910
Control	B. Aus, LV	11.72	49.56	34.81	3.16	0.74	0.00	9102
	T. Aus, LV	7.36	64.78	22.90	4.62	0.35	0.00	11557
	T. Aus, HYV	7.68	65.16	25.62	1.54	0.00	0.00	11618
	B. Aman, LV	10.93	50.20	37.10	1.68	0.09	0.00	7703
	T. Aman, LV	9.86	54.17	32.25	3.65	0.08	0.00	8206
	T. Aman, HYV	-	-	-	-	-	-	-
	Boro, LV	5.98	64.44	26.73	1.47	0.30	1.08	11110
	Boro, HYV	4.97	53.61	24.51	14.08	2.83	0.00	12124
	Avg.(weighted)	10.30	59.86	26.14	2.99	0.27	0.45	8106

Source: FAP - 12 PIE Household Survey

Table 4.10 Proportion of Production Input Value by Inputs: Non-Paddy Crops

Area Characteristics	Crops	Seed/ Seedlings (%)	Human Labour (%)	Animal Labour (%)	Fertilizer manure (%)	Pesticide (%)	Irrigation (%)	Total (Tk)
Impacted Protected	Jute	7.38	70.46	22.16	0.00	0.00		33451.35
	Summer Vegetbles	2.67	90.66		6.67			3086.65
	Winter Vegetables	0.68	80.12	12.23	5.27	1.70		24230.71
Impacted Unprotected	Potato	8.20	38.19	38.19	15.42			11641.94
	Chilli	26.20	52.40	6.12	10.92	4.36		28281.50
Control								

Source: FAP - 12 PIE Household Survey

Table 4.11 Per Hectare Use of Production Inputs: Paddy Crops

Area Characteristics	Paddy	Seed/ Seedlings (Tk.)	Human Labour (m-d)[1]	Animal Labour (p-d)[2]	Fertilizer (kg.)	Manure (mt.)	Pesticide (kg.)	Irrigation Water (Tk.)
Impacted Protected	B. Aus, LV	627	123	23	5	1.04	0.13	0.00
	T. Aus, LV	986	144	44	116	16.23	0.82	99.79
	T. Aus, HYV	605	135	37	273	35.22	3.08	0.00
	B. Aman, LV	616	87	35	3	15.68	0.00	0.00
	T. Aman, LV	760	97	24	60	5.26	1.34	0.00
	T. Aman, HYV	1278	167	39	166	63.13	0.00	0.00
	Boro, LV	659	174	38	126	12.39	2.21	574.69
	Boro, HYV	628	152	34	332	29.54	5.49	1791.86
	Avg. (weighted)	771	131	31	133	15.70	2.33	257.67
Impacted Unprotected	B. Aus, LV	867	171	41	144	56.69	2.91	0.00
	T. Aus, LV	560	121	34	35	1.78	1.09	107.39
	T. Aus, HYV	631	205	56	321	123.50	8.36	0.00
	B. Aman, LV	823	45	33	0	0.00	0.00	0.00
	T. Aman, LV	732	131	38	55	5.51	0.00	0.00
	T. Aman, HYV	1104	179	36	138	19.88	0.00	0.00
	Boro, LV	708	174	34	184	4.69	7.31	730.75
	Boro, HYV	648	188	34	293	12.18	16.63	1663.20
	Avg. (weighted)	713	150	36	136	8.78	2.73	516.89
Control	B. Aus, LV	1066	97	40	21	31.29	0.68	0.00
	T. Aus, LV	850	163	33	90	16.03	0.40	0.00
	T. Aus, HYV	893	88	37	30	0.00	0.00	0.00
	B. Aman, LV	842	98	36	3	19.09	0.06	0.00
	T. Aman, LV	809	94	33	10	24.21	0.06	0.00
	T. Aman, HYV	-	-	-	-	-	-	-
	Boro, LV	664	155	37	19	9.92	0.32	0.00
	Boro, HYV	602	232	37	139	0.00	3.43	120.09
	Avg. (weighted)	835	110	36	14	20.61	0.22	36.48

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

Table 4.12 Per Hectare Use of Production Inputs: Non-Paddy Crops

Area Characteristics	Crops	Seed/ Seedlings (Tk.)	Human Labour (m-d)[1]	Animal Labour (p-d)[2]	Fertilizer (Kg.)	Manure (Kg.)	Pesticide (kg.)	Irrigation water (Tk.)
Impacted Protected	Jute	2470.00	428.57	74.10	0.00	0.00	0.00	
	Summer Vegetbles	82.32	50.88	-	41.17	0.00	0.00	
	Winter Vegetables	164.67	119.19	29.64	205.82	24.70	4.12	
Impacted Unprotected	Potato	955.07	80.84	44.46	288.17	0.00		
	Chilli	7410.00	269.45	17.29	370.50		12.35	
Control								

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

Table 4.13 Percentage of Cultivated Area Irrigated by Different Means.

Seasons	Impacted						Control		
	Protected			Unprotected					
	Total Cropped Land (ha.)	% area irrigated		Total Cropped Land (ha.)	% area irrigated by		Total Cropped Land (ha)	% area irrigated by	
		Indigenous method	Mechanical method		Indigenous method	Mechanical method		Indigenous method	Mechanical method
Aus	7.76	28.86	-	6.33	-	3.79	17.65	0.96	-
Aman	52.96	18.58	2.28	39.64	8.58	3.48	57.55	5.65	-
Boro	50.71	49.61	38.14	30.04	29.93	64.08	18.16	51.10	5.56

Source: FAP - 12 Farm Household Survey.

Table 4.14 Per Hectare Cost of Production, Yield and Return by Crops

Crops/Cost Return	Impacted Area		Control Area
	Protected	Unprotected	
1. B. Aus, LV			
A. Grain Yield (tons)	1.75	2.11	1.30
By Product (tons)	3.50	4.22	2.60
B. Total Cost of Production (Tk.)	5378.00	11403.00	9101.00
C. Gross Return (Tk.)	15103.00	18252.00	11219.00
D. Net Return (Tk.)	9725.00	6849.00	2118.00
2. T. Aus, LV			
A. Grain Yield (tons)	1.41	1.81	1.71
By Product (tons)	2.82	3.62	3.42
B. Total Cost of Production (Tk.)	11997.00	9873.00	11557.00
C. Gross Return (Tk.)	11816.00	15168.00	14330.00
D. Net Return (Tk.)	(-)181.00	5295.00	2773.00
3. T. Aus, HYV			
A. Grain Yield (tons)	2.90	2.59	0.94
By Product (tons)	2.90	2.59	0.94
B. Total Cost of Production (Tk.)	12418.00	18205.00	11617.00
C. Gross Return (Tk.)	20532.00	18337.00	17256.00
D. Net Return (Tk.)	8114.00	132.00	5639.00

Table 4.14 Per Hectare Cost of Production, Yield and Return by Crops (Continued)

Crops/Cost Return	Impacted Area		Control Area
	Protected	Unprotected	
4. B. Aman, LV			
A. Grain Yield (tons)	0.86	0.78	0.65
By Product (tons)	0.86	0.78	0.65
B. Total Cost of Production (Tk.)	6829.00	6051.00	7702.00
C. Gross Return (Tk.)	8093.00	6082.00	6117.00
D. Net Return (Tk.)	1264.00	31.00	(-)1585.00
5. T. Aman, LV			
A. Grain Yield (tons)	1.75	1.42	1.10
By Product (tons)	3.50	2.84	2.20
B. Total Cost of Production (Tk.)	8233.00	9961.00	8206.00
C. Gross Return (Tk.)	17780.00	14427.00	11176.00
D. Net Return (Tk.)	9547.00	4466.00	2970.00
6. T. Aman, HYV			
A. Grain Yield (tons)	2.20	1.00	-
By Product (tons)	2.20	1.00	-
B. Total Cost of Production (Tk.)	11381.00	11304.00	-
C. Gross Return (Tk.)	17776.00	8340.00	-
D. Net Return (Tk.)	6395.00	(-)2964.00	-
7. Boro, LV			
A. Grain Yield (tons)	1.68	1.94	1.15
By Product (tons)	3.36	3.88	2.30
B. Total Cost of Production (Tk.)	12077.00	15066.00	11100.00
C. Gross Return (Tk.)	13894.00	16044.00	9511.00
D. Net Return (Tk.)	1817.00	978.00	(-)1589.00
8. Boro, HYV			
A. Grain Yield (tons)	3.70	3.64	3.43
By Product (tons)	3.70	3.64	3.43
B. Total Cost of Production (Tk.)	14175.00	14916.00	12123.00
C. Gross Return (Tk.)	25234.00	24825.00	23393.00
D. Net Return (Tk.)	11059.00	9909.00	11270.00
Weighted Average all paddy	7040.00	4957.33	660.00
9. Potato			
A. Grain Yield (tons)	-	2.54	-
By Product (tons)	-		-
B. Total Cost of Production (Tk.)	-	11642.00	-
C. Gross Return (Tk.)	-	7620.00	-
D. Net Return (Tk.)	-	(-)4022.00	-
10. Chilli			
A. Grain Yield (tons)	-	14.00	
By Product (tons)	-	-	
B. Total Cost of Production (Tk.)	-	28282.00	
C. Gross Return (Tk.)	-	145215.00	
D. Net Return (Tk.)	-	116933.00	
11. Winter Vegetables			
A. Grain Yield (tons)	3.06		
By Product (tons)	-		
B. Total Cost of Production (Tk.)	19431.00		
C. Gross Return (Tk.)	20655.00		
D. Net Return (Tk.)	1224.00		
12. Jute			
A. Grain Yield (tons)	7.24	-	-
By Product (tons)	14.48	-	-
B. Total Cost of Production (Tk.)	33391.00	-	-
C. Gross Return (Tk.)	75151.00	-	-
D. Net Return (Tk.)	41760.00	-	-
13. Summer Vegetables			
A. Grain Yield (tons)	1.85		
By Product (tons)			
B. Total Cost of Production (Tk.)	3007.00		
C. Gross Return (Tk.)	11100.00		
D. Net Return (Tk.)	8093.00		

5 FISHERIES

5.1 CAPTURE FISHERIES

To assess the impact of the Project on capture fisheries 20 fishermen were interviewed out of an estimated 400 fishermen in the Project area and 15 fishermen were interviewed out of an estimated 500 fishermen in the control area. The present figure of fishermen in the Project area corresponds well with the figure of 410 fishermen estimated during the pre-project period (Baseline Survey).

The average daily catch and average number of fishing days per year per fisherman was assessed from the responses of fishermen during the PIE study and are set out in Tables 5.1 and 5.2.

Table 5.1 Average Capture Fish Catch per Fisherman per Day (Kg).

Items	Impacted area	Control area
Now	2.6	2.2
Before	3.7	2.6

Source: FAP 12 PIE Household Survey.

Table 5.2 Average Number of Fishing Days per Fisherman per Year.

Items	Peak Period	Lean Period	Total
Impacted Area			
Now	136	63	199
Before	164	80	244
Control Area			
Now	123	64	189
Before	142	66	208

Source: FAP 12 PIE Household Survey.

From Table 5.1 it is evident that the average daily catch has decreased significantly both in impacted and control areas, but the rate of decline is greater in the impacted area (30 per cent) than in control area (15 per cent). It confirms the finding of the RRA study that fish output had declined by 25-30 per cent, after the Project. Similarly, the average number of fishing days per fisherman has also decreased (Table 5.2). This decline in the impacted area is slightly over double that of the control area, confirming the findings of the RRA. The relatively small size of the PIE sample could not provide information about landing volume of fish in each landing site, the types, number and changes in the fishing community. Accurate assessment of this information needs to be carried out for each Project area, if possible, by Upazilas in subsequent project evaluation studies.

The peak and lean fishing periods are found to be governed by the timing and duration of floods. The duration was found to vary with the type of water body, being higher in rivers

and lower in beels.The peak fishing period extends from July - December in rivers, September - January in channels and October - January in beels. No difference in duration of fishing is observed in rivers between the impacted and control areas, but slight differences are reported between channels and beels. This may be related to delayed flooding in the Project area.

Fishermen's responses regarding their catch by average quantity and value, and by main fish species, are shown in Table 5.3.

Table 5.3 Average Catch per Fisherman During 1990/91 (Quantities in Kg and Values in TK.)

Species	Impacted		Control	
	Quantity	Value	Quantity	Value
Major Carps	33	1873	5	350
Catfish	35	2096	29	1947
Hilsa	52	2090	13	552
Snakeheads	43	1366	13	678
Tilapia	-	-	-	-
Minor Carps	3	95	-	-
Live Fish	40	1930	15	916
Shrimp	94	2647	51	1588
Other Species	102	3384	103	3960
Total Capture Fish	402	15481	229	9991
Pond Fish (Mainly Carp)	-	-	-	-
Overall Total	402	15481	229	9991

Source: FAP 12 PIE Household Survey.

Fishermen were not asked for the size and value of catches prior to the Project,since recall problems were anticipated. An attempt was however made to ascertain their present (1990/91) catch position as compared to pre-project catches. The magnitude of change is indicated in Table 5.4.

Table 5.4 Comparison of 1990/91 and Pre - Project Catches
(No. of Fishermen Responding)

Extent of Changes	Impacted	Control
Increased more than 25%	-	-
Increased upto 25%	-	-
Catch about the same	1	-
Decreased upto 25%	6	10
Decreased more than 25%	13	5
Total No. of respondents	20	15

Source: FAP 12 PIE Household Survey.

The average catch for all individual species in the impacted area is at least equal to that in the control, and average total catch is higher (Table 5.3). This may partly be due to variations in fish stock in the water bodies and also partly due to differences in techniques

used by the fishermen. Moreover, the impacted area is not fully protected. In the part that is fully protected, the fishermen's co-operatives are engaged in stocking major carp species, which may have contributed to the large average catch of major carps in the impacted area, compared to the control area. According to the fishermen, fish production including commercially important species is decreasing (Table 5.4 and 5.5), and the decrease is relatively higher in the impacted area than in the control area. Sixty five per cent of the Project area fishermen claimed losses in excess of 25 per cent compared to 33 per cent in the control area. The extent of decrease in fish production (25-30 per cent) estimated in the impacted area during the RRA agrees with the results of the PIE.

Table 5.5 Changes in Specieswise Composition in the Catch.
(No of Fisherman Responding).

Species	Area	Increase		No Change	Decrease	
		25% plus	Upto 25%		Upto 25%	25% plus
Major Carps	Impacted	-	-	1	4	8
	Control	-	-	1	7	-
Catfish	Impacted	-	-	-	2	-
	Control	-	-	-	-	-
Hilsa	Impacted	-	-	-	-	-
	Control	-	-	-	1	-
Livefish	Impacted	-	-	-	-	1
	Control	-	-	-	2	-
Minor Carps	Impacted	-	-	-	1	2
	Control	-	-	-	1	-
Snakehead	Impacted	-	-	-	-	-
	Control	-	-	-	-	-
Shrimp	Impacted	-	-	-	-	-
	Control	-	-	-	-	-
Other Species	Impacted	-	-	-	-	-
	Control	-	-	-	1	-

Source: FAP 12 PIE Household Survey.

Fishermen's views on the causes of the decline in fish output are reported in Table 5.6.

Table 5.6 Views of Fishermen Causes of Project Impact.
(No. of Responses).

Causes of Impact	Impacted Area	Control Area
Fish access blocked by embankment	7	-
Excess use of fertilizers & pesticides	7	1
Fish disease	2	12
Excess capture of immature fish	3	8
Use of current net	1	6
Drying of water bodies	4	2
Decrease in fishing area	1	-
Difficulty of water transport	1	-
God's will	1	1

Source: FAP 12 PIE Household Survey

Blockage of the migratory route of fish by the embankments has been cited as an important direct factor reducing the fish catch in the impacted area. In addition, excessive use of fertilizers and pesticides are thought to be important indirect contributing factors. Fish disease and excessive capture of immature fish by current nets and other small mesh nets are important non-project factors.

Fishermen's income and expenditure were assessed from their responses as detailed below.

Table 5.7 Fishermen's Income and Expenditure, 1990/91 (TK.)

Items	Impacted Area	Control Area
Average catch (Kg.)	402	229
Fish kept for home consumption (Kg.)	47	24
Quantity sold (Kg.)	355	205
Mean value (Weighted average) Tk./Kg.	38.3	43.2
Gross income	13596	8860
Boat costs-uptake & depreciation	1410	880
Fishing gear repairs & replacements	1640	675
Licences, leases, other costs	550	15
Total costs	3600	1570
Net income	9996	7290

Source: FAP 12 PIE Household Survey.

The variations in costs and incomes between fishermen of both the areas may be associated with different kinds of gear and types of water bodies used for fishing.The costs and incomes of fishermen shown in Table 5.7 are mainly from capture fisheries, as there is little pond fish culture in either the impacted or the control areas.

The involvement of family members in fishing was also recorded during the PIE survey (Table 5.8).

Table 5.8 Involvement of Family Members in Fisheries Work. (Percentage of total fisheries related work by members)

Items	Impacted Area	Control Area
Men		
Fish catching	17	13
Boat & gear repairing	21	33
Fish processing	2	1
Fish trading	22	18
Wives and Children		
Fish catching	2	1
Boat & gear repairing	28	27
Fish processing	3	7
Fish trading	5	-
Total percentage	100	100

Source: FAP 12 PIE Household Survey.

The above table shows interesting information on involvement of family members in fisheries works. The fishermen are found to be involved almost equally in fishing, fish trading and boat and gear repairing, whereas their wives and children play a significant role in repairing gear and other fishing related equipment. Fishermen and their family members have little involvement in fish processing and trading.

5.2 FISH FARMING/ POND FISH CULTURE

Since the Project is of a submersible type, most of the ponds within it are over - topped by flood water annually. Hence no information on pond fish culture could be recorded during the PIE survey. Similarly, the control area is flood prone for which reason no evidence of cultural fisheries was found there during the PIE. The only siginificant development of culture fishery is the stocking of the residual beels in Haparu Haor with carp. Although the fish are free to move within the area of the haor when water levels are high (and some probably escape through the sluices) the embankment offers sufficient containment to protect the investment. This could be a model for fisheries development in compartments subject to controlled flooding, but with embankments which are not actually overtopped.

5.3 FISH TRADING

Three traders from the impacted area and two from the control area (one per market) were purposively selected for interview. This small sample of traders constitutes a set of case studies of fish traders in the respective areas, and the results can be regarded as indicative only.

There is hardly any information about fish traders in Bangladesh. During the RRA it was reported that many fishermen engaged in petty trading, and other residual activities, after the project, because of decreasing catch size. A 45 per cent increase in the number of fish traders was recorded in the PIE survey which does not necessarily contradict the RRA findings; in other PIE areas it is known that displaced fishermen have tried to move into fish trading, despite the resulting fall in turnover per trader. No increase in the number of traders is recorded in the control area.

The quantity of fish handled by the traders appears to have declined by about 23-30 per cent, both in impacted and control areas, which may partly be due to a decrease in fish production and partly to increased number of traders. Consequently the daily volume of fish handled by each trader at each market has also declined by about 22 per cent in the impacted and 30 per cent in the control area during the peak period. Many non-project related problems are faced by traders, which are not discussed here. However, traders' reports about the changes in fish output have been compared with the changes cited by the fishermen.

Changes in supply of various fish species in the Project and control areas reported by the traders are shown in Table 5.9.

Table 5.9 Changes in Supply of Fish by Species/Groups (No. of traders responding)

Fish Species/Group	Impacted area	Control area
Decreased		
Major carps	1	-
Boal/Pabda	2	-
Baim	-	2
Hilsa	1	-
Chital/Fali	2	-
Shing/Magur/Koi (Live fish)	1	2
Snake-head	-	-
Minor carps	2	-
Shrimp	-	-
Other species	-	-
Increased		
None		

Source: FAP 12 PIE Household Survey.

The traders' responses are in conformity with that of the fishermen in terms of decreases in different species of stock and their yields.

The traders are of the opinion that the main reasons for decline in fish production are capture of immature fish, fish disease and blockage of fish access by the embankment.

5.4 CONCLUSIONS

The adverse impact of the Zilkar Haor Project on fisheries is smaller than that of the other four projects studied by PIE, due to the submersible type of embankment which allows delayed flooding within the Project. Even the small decline appears to have reduced employment in this sector, reducing previously full-time fishermen to part-time ones. The problem is aggravated by indiscriminate fishing, but can in part be solved by promotion of culture fisheries in the fully protected Haparu Hoar.

The overall estimated outcome of the Project in terms of fish production and gain is illustrated in Table 5.10.

Table 5.10 Zilkar Haor - Fisheries Losses and Gains

1.	Area Data		
	Gross area = 5263 ha (4251 ha net)		
	Estimated flood land was 2980 ha		
	Area of floodland now drained	300 to 725 ha	
	Area of remaining floodland	2680-2255 ha	
	Area of beels was about 400 ha		
	Area of beels, now about 260 ha (RRA est.)ie loss	50-140ha	
	Area of beels remaining	350-260ha	
	Area of internal khals etc.	20-20ha	
	Area of external rivers (shared) 40 km x 0.2/2	400-400ha	
2.	Fisheries Losses		
	a) Floodplain fully drained	@37kg/ha	11mt. - 27mt.
	b) Floodplain still flooded	@20kg/ha	54mt. - 45mt.
	c) Perennial beels drained	@400kg	20mt. - 56mt
	d) Remaining beels areas	@75kg/ha(*)	26mt. - 19mt.
	e) Internal khals,	@15kg/ha	0.3mt. - 0.3mt.
	f) External rivers	@15kg/ha	6mt - 6mt
			117mt - 153mt
3.	Culture Fishery Gains.		
	Area & production of ponds negligible Culture based beel fisheries in Haparu Haor (upto 6 beels/119ha) now producing @ 600kg/ha instead of 400 before		
	Therefore, gain = 50 upto 119 x 200		10mt - 24mt.
4.	Net Loss :		107mt - 129mt.
	Assumes that Loss for submersible embankment is less than for full FCD project.		

6 LIVESTOCK

6.1 INTRODUCTION

Livestock are an integral part of the farming system in the Project area. Animals are kept primarily as a supporting activity to crop production and secondarily as a source of animal protein (milk, meat eggs) and cash income to the farm households. Most of the farm households keep a small number of livestock as scavenging animals.

Cattle, chickens and ducks are the most numerous types of animals in the Project area. A few buffaloes, goats and sheep are kept by some households. Economically, cattle are the most important animals in the Project area. Bullocks are kept mainly for draught power and cows for milk and calves. However, small and marginal farmers often use cows as draught animals for land preparation. During the peak ploughing season cows are also used as draught animals by all types of farm households to overcome shortage of draught power.

The Project, in common with nearly all FCD/I developments, had no explicit objectives related to livestock development. The planners, at the time of project planning, rarely consider project impacts on inputs and outputs of livestock, particularly draught power requirements, and how to meet the increased demand of draught power for timely land preparation. It is however likely that FCD/I projects will have an impact on livestock due to reduced grazing area if crop area expands, while on the other hand successful projects will increase wealth and ability to acquire livestock.

Zilkar Haor, like other FCD/I projects, may not have a direct impact on livestock production, but it could affect livestock feed resources and the incidence of disease, which will in turn influence livestock production in the area. The impact on livestock might be expected in the following areas :

- number of households owning livestock and holding size;
- livestock feed resources;
- draught power availability and demand;
- livestock outputs;
- livestock health and incidence of diseases;

In this Chapter an attempt is made to assess the impacts of the Project on livestock production, on the basis of the PIE household survey data and the RRA results.

6.2 DISTRIBUTION OF PIE SAMPLE HOUSEHOLDS

In total 245 sample households from protected, unprotected and control areas were interviewed, and detailed information on livestock production was collected. The distribution of sampled households by landholding and livestock ownership categories is shown in Table 6.1.

Table 6.1 Distribution of PIE Sample Households

	Impact Area		Control Area	Total Sample
	Protected Area	Unprotected		
Landless Household	25	20	23	68
Bovine owning HH	1	3	3	7
Ovine owning HH	0	0	3	3
Poultry owning HH	4	6	9	19
Marginal + Small HH	37	29	23	89
Bovine owning HH	27	20	14	61
Ovine owning HH	3	1	1	5
Poultry owning HH	28	19	20	67
Medium +Large HH	33	21	34	88
Bovine owning HH	21	18	34	73
Ovine owning HH	1	1	0	2
Poultry owning HH	27	18	34	79
All type of HH	95	70	80	245

Note : HH = Households
Source: PIE Household Survey

6.3 IMPACTS ON LIVESTOCK HOLDINGS

6.3.1 Change in Number of Livestock Owning Households

The results of the PIE household survey show that bovines are the most important type of livestock in the Project area, and that about 60-64 per cent of all households possessed bovines in small numbers. There is little difference between protected, unprotected and control areas in overall level of bovine ownership, but marginal and small farmers are less likely to own bovines in the control area (Table 6.2). Cattle are the most important species of bovine, while buffaloes are rarely kept, except by a few medium and large farm households.

The results show, not unexpectedly that the number of bovine holding households increases with the increasing farm size (Table 6.3). Only 5-15 per cent of the landless households and around 60-70 per cent of marginal and small farm households possessed bovines, while 90-100 per cent of the medium and large farm households possessed bovine animals.

Table 6.2 Distribution of Livestock Owning Household
(% owning)

Species	Impacted Area		Control Area
	Protected Area	Unprotected Area	
Bovine	63	59	64
Cattle	60	59	61
Buffaloes	4	0	3
Ovine (Goats+Sheep)	4	3	5
Poultry	62	61	79
Chicken	62	59	79
Ducks	38	39	21

Source: PIE Household Survey.

Table 6.3 Distribution of Bovine Owning Household Based on Farm Size.
(% owning)

Farm Size	Impacted Area		Control Area
	Protected Area	Unprotected Area	
Landless Household	4	15	13
Marginal + Small Farm Household[1]	73	69	61
Medium + Large Farm Household[2]	97	86	100

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

Source: PIE Household Survey .

The PIE results show that ovines (goats and sheep) are not important in the Project area. Only 3-5 per cent of the total households possessed ovines (Table 6.2). The number of ovine holding households does not change with size of landholding, nor does it differ between the protected and control areas (Table 6.4). In the haor area, where most of the land remains under flood water for 4-5 months of the year and homesteads have very limited space, there is very limited scope for small ruminant production.

The PIE results indicate that poultry are important in the Project area. Around 60-80 per cent of households possessed poultry. Chickens are the predominant species. Only 20-40 per cent of households have ducks. The PIE results indicate that there are fewer chicken

owning households in the protected and unprotected areas than in the control area, but the number of duck owning households is higher in the protected and unprotected areas than in the control area. The difference in the number of poultry owning households between the protected and control areas appears to be significant (Table 6.2).

Table 6.4 Distribution of Ovine Owning Household by Farm Size (% owning).

Farm Size	Impacted Area		Control Area
	Protected Area	Unprotected Area	
Landless Household	0	0	13
Marginal + Small Farm Household[1]	8	3	3
Medium + Large Farm Household[2]	3	5	0

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

Source : PIE Household Survey .

The PIE results indicate further that the proportion of poultry owning households increases with size of landholding in both the impacted and control areas (Table 6.5).

6.3.2 Change in the Size of Livestock Holding

The PIE household survey data and the RRA results indicate that the size of livestock holding per household is quite small. It varies with a number of factors, including species and size of landholding, and between protected and control areas.

The average size of bovine holding per household is very small at 2.5 head per household (Table 6.6). Cattle have the predominant share and buffaloes contribute about 4 per cent. The size of bovine holdings per household is higher in the control area than the protected area. Table 6.7 shows the average size of bovine holdings per owning household. The average number of bovines per owning household was again higher (4.6 head per owning household) in the control area than in the protected area (3.8 head per owning houshold). The average bovine owning household keeps at least two bovine animals for ploughing.

Table 6.5 Distribution of Poultry Owning Households by Farm Size
(% owning)

Farm size	Impacted Area		Control Area
	Protected Area	Unprotected Area	
Landless Household	16	30	39
Marginal + Small Farm Household[1]	76	66	87
Medium + Large Farm Household[2]	82	90	100

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

Source: PIE Household Survey.

Table 6.6 Number of Livestock per Household

Species	Impacted Area		Control Area
	Protected Area	Unprotected Area	
Bovine	2.4	2.0	2.9
Cattle	2.3	2.0	2.8
Buffaloes	0.1	0	0.1
Ovine (Goats+Sheep)	0.2	0.1	0.2
Poultry	6.2	7.4	6.2
Chicken	4.4	4.2	5.5
Ducks	1.8	3.2	0.7

Source: PIE Household Survey.

Table 6.7 Number of Livestock per Owning Household

Species	Impacted Area		Control Area
	Protected Area	Unprotected Area	
Bovine	3.8	3.4	4.6
Cattle	3.8	3.4	4.5
Buffaloes	3.3	0	6.0
Ovine (Goats+Sheep)	2.8	2.0	4.8
Poultry	10.0	12.0	7.9
Chicken	7.0	7.2	7.0
Ducks	4.8	8.2	3.7

Source: PIE Household Survey.

Table 6.8 Number of Bovine Animals per Owning Household by Farm Size.

Farm Size	Impacted Area		Control Area
	Protected Area	Unprotected Area	
Landless household	0.2	0.3	0.4
Marginal + Small Farm Household[1]	2.0	2.0	2.1
Medium + Large Farm Household[2]	4.6	3.5	5.2

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

Source: PIE Household Survey.

The smaller number of bovine animals per household in the protected area indicates that the Project may have had a negative impact on the bovine population. The RRA findings indicate a decline in the cattle population between the pre-and post-post project situations, which would support the PIE evidence.

Table 6.9 Number of Bovine Animals per Owning Household by Farm Size.

Farm Size	Impacted Area		Control Area
	Protected Area	Unprotected Area	
Landless household	4.0	2.0	2.7
Marginal + Small Farm Household[1]	2.7	3.0	3.5
Medium + Large Farm Household[2]	4.7	4.1	5.2

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

Source: PIE Household Survey.

The PIE results indicate that ovines are not economically important in the Project area. The average size of ovine holding is only 0.2 head per household (Table 6.6).

There is no difference in the ovine holding per household between the protected and control areas. The ovine holding per owning household is around 2.8 head per owning household in the protected area compared with 4.8 head in the control area but the sample size is too small to attribute significance to this. Lack of high land in the area may be a reason for the low goat and sheep population.

Table 6.10 Number of Ovines per Household by Farm Size.

Farm size	Impacted Area		Control Area
	Protected Area	Unprotected Area	
Landless Household	0	0	0.7
Marginal + Small Farm Household[1]	0.2	0.1	0.1
Medium + Large Farm Household[2]	0.1	0.1	0

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

Source : PIE Household Survey .

Table 6.11 Number of Ovine per Owning Household by Farm Size.

Farm size	Impacted Area		Control Area
	Protected Area	Unprotected Area	
Landless Household	0	0	5.7
Marginal + Small Farm Household[1]	2.3	2.0	2.0
Medium + Large Farm Household[2]	4.0	2.0	0

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

Source: PIE Household Survey

The household survey results on the size of poultry holding in the protected and control areas are presented in Tables 6.6 and 6.7. It can be seen that the average size of poultry holding per household does not vary consistently between the protected and control areas. The size of chicken holding per household was smaller in the protected area than in the control area. The size of duck holding, on the contrary, was higher in the protected area than in the control area.

Tables 6.12 and 6.13 show the size of poultry holding by size of farm holding. The results show that the size of poultry holding increases with operated land holding of the household. The average landless household possessed only 2.0 birds per household, while marginal and small farm households possessed 6-7 birds and medium and large farm households possessed 9-12 birds per household. There is no consistent variation between the protected and control areas.

Table 6.12 Number of Poultry per Owning Household by Farm Size.

Farm size	Impacted Area		Control Area
	Protected Area	Unprotected Area	
Landless household	1.3	1.7	3.0
Marginal + Small Farm Household[1]	5.8	7.1	7.0
Medium + Large Farm Household[2]	10.3	13.1	7.8

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

Source: PIE Household Survey .

Table 6.13 Number of Poultry per Owning Household by Farm Size.

Farm size	Impacted Area		Control Area
	Protected Area	Unprotected Area	
Landless Household	8.3	5.7	7.6
Marginal + Small Farm Household[1]	7.7	10.8	8.1
Medium + Large Farm Household[2]	12.6	15.3	7.8

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

Source: PIE Household Survey .

6.4 IMPACT ON DRAUGHT POWER

6.4.1 Change in Draught Power Requirement

It is anticipated that the Project would have some impact on draught power requirements in the area. Improved drainage facilities as well as assured protection of Boro paddy against flash floods have led to changes in the cropping pattern. The change in cropped areas in different seasons, due to the project, may cause changes in draught power requirements for land preparation in the project area.

The PIE results indicate that the operated land area per household does not vary significantly between the protected and control areas. However, cropped area per household in different seasons does vary between the protected and control areas (Table 6.14). Cropped area in the Aus and Aman seasons was higher in the control area than in the protected area, but the cropped area in the Boro season was significantly higher in the protected area than in the control area. The cropped area per household in the Aman season is the highest in all areas. This indicates that the draught power requirement will be the highest in the Aman season both in the protected and the control area.

6.4.2 Change in Draught Animal Availability

The supply of draught power for land preparation is the most important contribution by livestock to 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 vary with farm size, between the protected and control areas. Bullocks are the most important animals used for draught power. However, buffaloes and bulls are also used for draught power whenever available.

Table 6.14 Operated and Cropped Areas per Household by Crop Season (acres).

Operated land/HH (acre)	Impacted Area		Control Area
	Protected Area	Unprotected Area	
Total operated area	2.55	2.32	2.47
Cropped Area in:			
- Aus Season	0.20	0.26	0.53
- Aman Season	1.38	1.41	1.75
- Boro Season	1.32	1.06	0.52
- All season	2.90	2.73	2.80

Source: PIE Household Survey.

The composition of bovine holdings in the impacted and control areas is shown in Table 6.15. In general, bovine holdings comprised 45 per cent of bullocks/bulls, 29 per cent of cows, 21 per cent of calves and 5 per cent of buffaloes. There are some variations in the composition of bovine animals between the protected and control areas, but these differences are quite small.

Table 6.15 Composition of Bovine Holdings by Area.

No. of Animal/HH	Impacted Area		Control Area
	Protected Area	Unprotected Area	
Bullock+Bull/HH	1.11	0.97	1.24
Cows/HH	0.65	0.61	0.88
Calves/HH	0.51	0.40	0.64
Buffaloes/HH	0.14	0	0.15
Total Bovine/HH	2.41	1.98	2.91

Note: HH = household

Source: PIE Household Survey.

Since there is variation in the composition of bovine holdings, which differ in their draught power ability, it is necessary for comparison to convert all types of bovines into draught animal units (DAU) by using the following conversion factors.

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

The available DAU per household in the protected and control areas are shown in Table 6.16. It can be seen that the number of DAU per household was smaller in the protected area than in the control area. The results indicate that about 65 per cent of total DAU comes from bullocks/bulls, 20 per cent from cows, and 15 per cent from buffaloes in the Zilkar Haor area. Table 6.16 also shows the relationship between the operated land holding and DAU holding per household. The number of DAU per acre of operated land was smaller in the protected area than in the control area. This indicates that the farmers in the control area are in a better position with respect to cultivation of their lands than those in the protected area.

Table 6.16 Availability of Draught Animal Units per Household by Area

Draught animal/HH	Impacted Area		Control Area
	Protected Area	Unprotected Area	
Bullocks+Bulls/HH	1.11	0.97	1.24
Cows/HH	0.65	0.61	0.88
Buffaloes/HH	0.14	0	0.15
DAU/HH	1.71	1.28	1.98
DAU/Acre operated land	0.67	0.55	0.80

Source: PIE Household Survey Data.

6.4.3 Draught Power Demand and Supply

The demand for draught power will vary with the operated land holding and with the cropped area in different cropping seasons. As already shown in Table 6.14, the operated land area per household varies with the cropping season, and with farm size. The operated area per household is highest in the Aman season and lowest in the Aus season. In general, a pair of DAU will require 15-18 days for cultivation of one acre (0.40 ha.) of land, so that a pair of DAU can cultivate 2 acres of land in 30 days. The time available for land preparation is dependent on the cropping season and natural rainfall. In the Boro season, when irrigation water is used, the time available for land preparation is quite long, around 45-60 days, but in the Aus and Aman seasons, when land preparation and sowing/planting are dependent on natural rainfall, the time available for land preparation is very short, usually 25-30 days. Therefore, in the Aman season, when a greater area of land has to be cultivated in a short period of time, the supply of draught power for land preparation will be critical.

In order to investigate the demand for and supply of draught animals in the Aman season amongst medium and large farm households, PIE data are analysed and presented in Table 6.17. The area of land that has to be cultivated by a pair of DAU varies between the protected and control areas. The results show that the acreage of operated land that needs to be cultivated by a pair of DAU throughout the year is higher in the protected area than in the control area. However, there appears to be no absolute shortage of draught power for cultivating the available land in either the impacted/protected or control areas. Farmers in the impacted/unprotected area do however appear to face a shortage in the Aman season, judged by the standard of 30 days available cultivation time.

Table 6.18 shows the actual days required to cultivated the operated area with the available DAU of various categories of farm household. In this calculation an assumption is made that a pair of DAU will require 15 days to cultivate one are (0.40) ha) of operated or cropped land. It can be seen from the table that there is no significant shortage of draught power to cultivate the operated land in different cropping seasons even for medium and large farm households. However, the highest requirement of DAU was in the Aman season and the lowest requirement in the Aus season.

Table 6.17 Draught Power Requirement and Supply 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.)	1.71	1.28	1.98
Operated land/Pair DAU	2.99	3.64	2.50
Operated land/Pair DAU for M+L Farm HH	3.28	5.05	2.62
Cropped land/Pair DAU in Aman Season	1.62	2.21	1.77
Cropped land/Pair DAU in Aman Season for M+L farm HH	1.72	3.03	1.69

Source: PIE Household Survey Data.

Table 6.18 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	3	21	22	6	33	25	3	21	12
Medium + Large	4	26	24	9	46	31	9	28	7
All Type	4	24	23	6	33	25	8	27	8

Source: PIE Household Survey.

6.5 IMPACTS ON LIVESTOCK FEEDS

It may be anticipated that due to the project there would be some impact on livestock feed resources, particularly on fallow land and grazing area, and thereby on availability of green feedstuffs. The RRA results indicated that the grazing area has been reduced due to

conversion of fallow land into crop field. On the other hand, with the increased production of paddy there will be a concomitant increase in paddy straw and rice bran for bovine animals. The RRA results indicate that the straw production has increased in the Project area due to the protection of Boro paddy against flash floods. It is assumed that with the increased production of paddy there would also be increased production of rice bran in the area.

In order to find out the exact status of livestock feeds in the area, the PIE ascertained the number of households who spent money for feeding their bovine animals. The results are presented in Table 6.19.

Table 6.19 Incidence of Feed Purchases for Bovine Animals in Last 12 months (1990-91).

Areas	Type of Feeds Bought		
	Green feedstuff (% HH)	Dry feedstuff (% HH)	Concentrate feed (% HH)
Protected	7	43	53
Unprotected	4	39	44
Control	3	45	39

Source: PIE Household Survey.

Only a very small percentage of households purchase green feedstuff for their animals. On the contrary, around 45 per cent of the total households or 70 per cent of the owning households spent some money for dry roughage and/or concentrate feeds to feed their animals. With the exception of concentrate feed there is no great difference between the protected and control areas.

Table 6.20 shows the amount of money spent per household and per spending household for different types of feeds. The higher amounts of money were spent on dry roughage and concentrated feeds. There appears to be a significant difference in spending per household between the impacted and control areas, with the impacted area households spending much more. The difference is greatest for green feeds, but as noted above the sample of purchasing households for this type of feed is tiny, and it would be dangerous to read too much into the difference.

Table 6.20 Amount Spent per Household on Feeds in Last 12 Months.
(Taka)

Areas	Type of Feeds Bought					
	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	45	614	425	985	442	839
Unprotected	23	533	347	900	413	932
Control	6	250	338	751	191	493

Source: PIE Household Survey.

6.6 IMPACT ON LIVESTOCK HEALTH

The Project may have had some impact on livestock health and incidence of diseases. The RRA results indicate that there is a general deterioration of cattle health in the Project area mainly due to shortage of nutritious feeds, extreme seasonal fluctuation of feed supply and seasonal overwork of the animals, but it is not clear that these are Project impacts.

The PIE results indicate that about 40-50 per cent of households use veterinary facilities for treatment or vaccination of their animals (Table 6.21). However, there is no great difference in the use of veterinary facilities between the protected and control areas. The amount of money spent per household is also shown in Table 6.21. The results indicate that an average household spent only Tk. 120 per year for the treatment and vaccination of livestock. There was little difference in spending per household between the protected and control areas.

Table 6.21 Use of Veterinary Facilities and Amount Spent per Household

	Impacted Area		Control Area
	Protected Area	Unprotected Area	
% HH used Vet. Treatment	42	27	53
Amount Spent/HH for Treatment (Tk)	122	89	117
Amount Spent/Owning HH for Treatment (Tk)	291	327	223

Source: PIE Household Survey.

6.7 HOUSEHOLD INCOME FROM LIVESTOCK

Household income from sale of live animals as well as from livestock products is shown in Table 6.22. The results indicate that the income from sale of live animals is slightly higher in the protected area than in the control area. More than 90 per cent of the total sale of live animals, both in the protected and control areas, is accounted for by bovines.

Table 6.22 **Household Income from Sale of Live Animals and Livestock Products**
(Taka per household)

Sources of Income	Impacted Area		Control Area
	Protected Area	Unprotected Area	
Sale Proceeds from Live Animals	1141	662	1082
Bovine/HH	1095	611	945
Ovine/HH	19	0	61
Poultry/HH	27	51	76
Sale Proceeds from Livestock Products	1131	931	909
Milk/HH	399	444	551
Meat/HH	421	201	22
Eggs/HH	165	172	185
Others/HH	146	114	151
Total HH	2272	1593	1991

Source: PIE Household Survey.

Total sales per household from livestock products are also higher in the protected area than in the control area. About 35 per cent of the total sale proceeds from livestock products come from milk in the impacted area, compared with 60 per cent in the control area.

The net income per household from livestock sources is shown in Table 6.23. Although the gross income per household from livestock sources was higher in the protected area, the net income appears to be higher in the control area than in the protected area. This is mainly due to higher maintenance costs, particularly feed costs for bovine animals, in the protected area.

Table 6.23 Net Income/Household from Livestock Sources.

Item	Impacted Area		Control Area
	Protected	Unprotected	
Gross Household Income from Livestock	2272	1593	1991
Cost of Feeds and Treatment/HH	1034	872	652
Net Income/HH	1238	721	1339

Source : PIE Household Survey.

6.8 SUMMARY

It appears from the foregoing discussion that the Project may have had a slight negative impact on the bovine population. This has been indicated by the fact that the number of bovine animals per household was lower in the protected area, and the cost of feeding and maintenance of animals was higher than in the control area. The results indicate further, that the number of draught animal units (DAU) per household and per acre of land was lower in the protected area. However, there was no major difference in the DAU composition between the protected and the control areas, and there was no absolute shortage of DAU either in the Aman or Boro season in either the protected or the control areas.

Sheep and goats have little economic importance in the Project area. This is mainly due to the very small area of high land inside the Project suitable for small ruminant production. Poultry has some economic importance in the area. However, the number of chicken holding households as well as chicken holding size per household was lower in the protected area than the in control area. But the number of duck holding households and duck holding size per household were higher in the protected area than in the control area.

Average household income from sale of live animals and of livestock products was higher but net income was lower in the protected area than in the control area. This lower net income per household in the protected area is primarily due to the higher cost for feeding and maintenance of the animals.

6.9 RECOMMENDATIONS

The Project appears to have had a slight negative impact on feed resources, particularly green feedstuff availability and dry roughage (paddy straw) quality. There appears to be a slight negative impact on the bovine population and thereby draught power supply in the area. The following measures could be taken to overcome the adverse effect of the Project and to improve livestock production in the area.

i. There is a need to explore the technical and economic feasibility of devoting some cultivable fallow land to food cum forage crops (maize, sorghum) in order to minimize green feed shortages.

ii. Paddy straw, which is poor in digestibility and nutrient content, is the main feedstuff of cattle in the area. It has been established through research that urea treatment of straw improves both nitrogen content and digestibility. A large scale extension programme should be undertaken to popularize urea treatment of straw in the project area for improving cattle nutrition.

iii. A programme on introduction of urea molasses blocks for feeding bovine animals with the straw ration may be undertaken. Urea-molasses block is a good source of energy and nitrogen for rumen micro-organisations which is fact digest for fibrous feeds. Moreover, rumen micro-organisms are a good source of protein for the ruminant. So feeding urea-molasses black as supplemental feed for cattle on straw based ration will not only improve digestibility and palatability of straw but also improve total nutrient intake of the animal.

iv. The extension programme of the Department of Livestock Services should be extended and strengthened in the Project area. Provision should be made to provide routine vaccination and mass anthelmintic doses in the Project area to protect animals against prevalent viral, bacterial, and parasitic diseases.

v. As a long-term measure, during selection of HYV paddy some consideration should be given to straw quality because straw of some HYV has higher digestibility than that of others. This will help to improve straw quality along with increased rice production.

7 IMPACT ON NON-FARM ECONOMIC ACTIVITIES

7.1 INTRODUCTION

Agricultural growth is expected to give rise to growth in non-farm activities. Since the projects studied by FAP 12 have in most cases had some positive impacts on agricultural output, it is expected that there would be some linkage effects with non-farm activities. Since these effects are mostly indirect and given that there always exist 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 the trends of change, through direct observation and interviews with informed sources, during the PIEs short case studies were conducted in each of the PIE areas in order to substantiate the findings obtained during RRAs and to provide further insights into aspects of change.

In the case studies the key aspects investigated were, level (number of units) of activities, seasonality of production, employment (annual person days worked), production, income and demand. Non-farm activities are considered by FAP 12 to be essentially the small and rural industrial and trading activities and those related to fishing, livestock and forestry - the subsectors which fall under agriculture in the broader sense of the term, have not been considered. They do not, however, include trading activities (e.g. dealing in rice and agricultural inputs), shop keeping and transport business (e.g. rickshaw, van, boat). Given that FAP 12 found a wide range (more than 60) of non-farm activities, selecting the limited sample for study was not easy. However, respondents were selected from all the major activities encountered and thus provide an useful overview of the non-farm economy as a whole.

Non-farm activities vary greatly in capital, scale, and level of 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. Also, not all types of sample units were common to both impacted and control areas. In view of this, the information provided in some of the tables is indicative rather than definitive and provides only a general picture of the state of non-farm activities in areas concerned. Annual return figures, however, are standardised in the form of return to family labour and management. This approach avoids the problems of imputing a wage rate for family labour, much of which is part time and remunerated at levels well below the market wage.

The present set of case studies on Zilkar Haor was conducted in both impacted and control areas. In all 31 enterprises were interviewed, of which 16 were in the impacted area and 15 in the control area. Because of the purposive nature of sampling, statistical analyses and tests have not been conducted. Table 7.1 shows the distribution of enterprises by type and by age. It may be mentioned that older enterprises were purposively selected in order to obtain information on the situation in the pre-project period and thereby enable comparison with the post-project situation. As can be seen from the table, almost all the enterprises were established before the project was implemented. The average age of enterprise was about 18 years for the impacted area and 14 years for the control area. The table shows a considerable age variation among the enterprises. In general, wood, cane and bamboo works, net making, carpentry and blacksmithing are relatively older types of activities.

Table 7.1 Sample Enterprises Type and by Age

Activities	No. of units established							
	Impacted				Control			
	Before	After	No. of sample units	Av. age of units(yrs.)	Before	After	No. of sample units	Av. age of units (yrs.)
Rice milling	1	-	1	17.0	2	-	2	8.0
Wood, Cane & bamboo works	3	-	3	19.3	2	-	2	34.0
Net Making	1	-	1	40.0	-	-	-	-
Furniture making	-	-	-	-	1	-	1	10.0
Tailoring	1	-	1	10.0	2	-	2	7.0
Carpentry	1	-	1	30.0	1	-	1	25.0
Blacksmithing	1	-	1	44.0	1	-	1	9.0
Rickshaw pulling	-	1	1	20.0	-	-	-	-
Boatmen	3	-	3	13.7	2	1	3	9.0
Rice trading	2	-	2	7.0	1	-	1	22.0
Stationary/Grocery	1	-	1	7.0	1	-	1	8.0
Vegetable trading	1	-	1	6.0	1	-	1	9.0
All	15 (94.0)	1 (6.0)	16	17.8	14 (93.0)	1 (7.0)	15	14.1

Source : PIE Case Studies

7.2 OVERALL PROJECT IMPACT

Based on the findings of RRA, and on the case studies on rural enterprises an attempt has been made to scale the degree of Project impact on various nonfarm activities. In scaling the impacts, changes in key variables such as level (no. of units) of activities, employment (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

A rough scale of "overall impact" is obtained by summing the individual impact scores, as follows :

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

The scale of impact (positive or negative) that the Zilkar Haor Project has made on ten selected major non-farm activities, is assessed as follows:

Rice milling	+1	Ag. input marketing	+1
Wood, cane & bamboo products	+1	Rice trading	+2
Furniture & Carpentry	0	Rickshaw (Van)	+2
Blacksmithy	+2	Water transport	
Light engineering workshop	0	Earth work	+1
		Overall impact	+8

Thus, Zilkar Haor is assessed as having made a minor but positive impact on non-farm activities.

7.3 LEVEL OF ACTIVITIES

The Project area generally supports quite a number of non-farm activities. These include, among others, rice milling, cane and bamboo products, carpentry, furniture making, blacksmithing, trading and transport.

Following intensification of paddy production, mechanised rice milling in the project area has generally increased. Small husking mills, usually powered by STW engines but run during the off-season, have also slightly increased. With the growth of rice mills, however, the traditional method of rice husking by dheky has declined.

Like rice milling, trading in general and rice trading in particular appears to have increased. With the increased use of agricultural inputs such as fertilizer, seeds and pesticides, trading in such items has registered an increase in the project areas. Although there has been some increase in the use of mechanised irrigation, support facilities in the form of engineering workshops or repair facilities have not emerged, perhaps because these are available nearby in Sylhet town.

Wood, cane and bamboo works in the form of containers, winnower, hoes, yokes, ploughs have registered a modest growth. The activity of boat making, however, has declined.

The improvement in communication created through embankments and link roads has increased the number of low cost transport enterprises like rickshaws and rickshaw vans. Nevertheless, the Project has had clear negative impacts on the number of boatmen.

Apart from RRA findings, the community survey conducted during PIE gives some additional information on the growth of a few selected non-farm activities. This is presented in Table 7.2. As can be seen from the table, growth of rice mills and input marketing is higher in the impacted area, compared to the control area, whereas growth in oil mills is higher in the control area, compared to the impacted area. The decline of oil-milling has been generally found by FAP 12 in projects which have encouraged Boro cultivation, since Boro is more profitable than oilseeds.

Table 7.2 Growth of Selected Non-farm Activities

Activities	No. of units					
	Impacted (14 Mouzas)			Control (8 Mouzas)		
	Before	After	Change %	Before	After	Change %
Rice Mill	15	20	+33	4	5	+25
Oil Press	1	1	Nil	1	2	+100
Saw Mill	-	-	-	-	-	-
Light Engg. Workshop	-	-	-	-	-	-
Ag. Input marketing	2	5	+150	1	1	Nil

Source: PIE Community Survey.

7.4 SEASONALITY OF PRODUCTION

Tables 7.3 and 7.4 present the distribution of various types of enterprises by the seasonal duration of their activity for the impacted and control areas respectively. It appears from the tables that most of the enterprises are run on a seasonal basis. Activities such as net making, blacksmithing, rickshaw pulling, rice trading and vegetable trading are presently run year round in the impacted areas, while in the control areas, furniture making, blacksmithing, and vegetable trading are run year-round.

The number of days in operation appears to have increased in the case of blacksmiths, rice milling, tailoring, trading in general and rice trading in particular in the impacted area, while working days for boatmen have decreased. For other activities, the number of days has remained more or less the same. In the control area, however, working days appear to have slightly declined for rice milling and blacksmithing (Tables 7.5 and 7.6), and seasonal activity has not increased for any enterprise type.

7.5 EMPLOYMENT

Growth in the number of rice mills has given rise to employment opportunities in the impacted areas. However, employment in small rice hullers, operated with STW engines mostly in the off-seasons, is not entirely attributable to the Project. Like rice milling, rice trading has tended to support employment of, in particular, distressed women. The growth in rice mills and rice trading has linkage effects with transportation and agricultural input supply, eventually increasing non-farm employment opportunities. Thus, makers of agricultural implements have reported higher capacity utilisation.

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

Activities	Period of Operation (months)					
	Peak Period		Lean Period		Total	
	Before	After	Before	After	Before	After
Rice milling	4.0	4.0	4.0	4.0	8.0	8.0
Cane & bamboo works	5.7	5.7	3.7	3.7	9.4	9.4
Net Making	4.0	4.0	8.0	8.0	12.0	12.0
Furniture making	-	-	-	-	-	-
Tailoring	5.0	4.0	5.0	3.0	10.0	7.0
Carpentry	5.0	3.0	5.0	3.0	10.0	6.0
Blacksmithing	4.0	4.0	6.0	8.0	10.0	12.0
Rickshaw pulling	NA	9.0	NA	3.0	NA	12.0
Boatmen	4.7	2.7	6.0	7.0	10.7	9.7
Rice trading	7.0	7.5	5.0	4.5	12.0	12.0
Stationary/Grocery	4.0	4.0	-	2.0	4.0	6.0
Vegetable trading	4.0	4.0	8.0	8.0	12.0	12.0

Source: PIE Case Studies.

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

Activities	Period of Operation (months)					
	Peak Period		Lean Period		Total	
	Before	After	Before	After	Before	After
Rice milling	7.0	6.0	3.5	4.5	10.5	10.5
Cane & bamboo works	3.0	3.0	6.0	6.0	9.0	9.0
Net Making	-	-	-	-	-	-
Furniture making	4.0	4.0	8.0	8.0	12.0	12.0
Tailoring	3.5	3.5	5.0	5.0	8.5	8.5
Carpentry	5.0	5.0	5.0	5.0	10.0	10.0
Blacksmithing	3.0	3.0	9.0	9.0	12.0	12.0
Rickshaw pulling	-	-	-	-	-	-
Boatmen	3.7	3.7	3.7	3.7	7.4	7.4
Rice trading	2.0	2.0	6.0	6.0	8.0	8.0
Stationary/Grocery	3.0	3.0	3.0	3.0	6.0	6.0
Vegetable trading	2.0	2.0	10.0	10.0	12.0	12.0

Source: PIE Case Studies

Table 7.5 Days of Operation of Activities by Season - Impacted Area

Activities	Days of operation during						
	Peak Period		Lean Period		Total		
	Before	After	Before	After	Before	After	Change (%)
Rice milling	60	80	40	40	100	120	+20
Cane & bamboo works	168	168	81	81	249	249	nil
Net Making	112	112	160	160	272	272	nil
Furniture making	-	-	-	-	-	-	-
Tailoring	90	120	125	135	215	255	+19
Carpentry	45	90	75	75	120	165	+38
Blacksmithing	112	112	100	200	212	312	+47
Rickshaw pulling	NA	252	NA	60	-	312	-
Boatmen	136	71	109	99	245	170	-31
Rice trading	105	105	75	135	180	240	+33
Stationary/Grocery	120	120	-	60	120	180	+50
Vegetable trading	80	80	80	120	160	200	+25

Source: PIE Case Studies

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

Activities	Days of operation during						
	Peak Period		Lean Period		Total		
	Before	After	Before	After	Before	After	Change (%)
Rice milling	175	145	35	39	210	184	-12
Cane & bamboo works	90	90	135	135	225	225	nil
Net Making	-	-	-	-	-	-	-
Furniture making	120	120	120	120	240	240	nil
Tailoring	101	101	125	125	226	226	nil
Carpentry	150	150	100	100	250	250	nil
Blacksmithing	60	45	72	72	132	117	-11
Rickshaw pulling	-	-	-	-	-	-	-
Boatmen	110	110	100	100	210	210	nil
Rice trading	60	60	120	120	180	180	nil
Stationary/Grocery	90	90	90	90	180	180	nil
Vegetable trading	50	50	150	150	200	200	nil

Source: PIE Case Studies

Like many other FCD/I projects, the Project has had an adverse impact on navigation and in consequence has shortened the working periods of boatmen and perhaps, also of fishermen. The improved communication network, however, has compensated for this negative impact somewhat. More crops, vegetable and merchandise are now marketed, creating, in particular, part time or full time employment in small scale trading and in road transport. Construction of embankments and maintenance needs have helped to create short-term non-farm employment opportunities through earthwork.

As can be seen from Tables 7.5 and 7.6, most activities have experienced growth in output and employment in the impacted area.

From information presented in Tables 7.7 and 7.8, it can be seen that the sampled enterprises are by and large family based. The incidence of hired workers is insignificant for both impacted and control areas. The predominance of family workers, however, is slightly less in the enterprises in the control area. Most of the enterprises in the impacted area employ one worker - in other words, the entrepreneur himself!

As regards the present level of person days employed in selected activities, the tables show that compared to the control area, the average person days employed in the impacted area is higher for all activities, except grocery shop keeping and boat transport.

7.6 PRODUCTION AND INCOME

During the PIE case studies, entrepreneurs were asked for the extent of changes that have taken place in their production and income, and in demand for their products.

The percentage of enterprises reporting "increase", "decrease", or "same" are presented in Table 7.9. The resultant changes (positive or negative) in production and income have been weighted by the corresponding figures of production and income, and the overall change is presented in the last column of the table.

Table 7.7 Number of Persons Employed and Annual Person Days Worked by Activity (After the Project) - Impacted Area

Activities	Average employment			Annual person days employed		
	Family	Hired	Total	Family	Hired	Total
Rice milling	2.0	3.0	5.0	240	360	600
Cane-bamboo products	3.3	-	3.3	822	-	822
Net making	3.0	-	3.0	816	-	816
Furniture making	-	-	-	-	-	-
Tailoring	1.0	-	1.0	255	-	255
Carpentry	3.0	-	3.0	495	-	495
Blacksmithing	1.0	-	1.0	312	-	312
Rickshaw pulling	1.0	-	1.0	312	-	312
Boatmen	1.7	0.3	2.0	289	51	340
Rice trading	2.0	-	2.0	480	-	480
Grocery/Stationery	1.0	-	1.0	180	-	180
Vegetable trading	2.0	-	2.0	400	-	400

Source: PIE Case Studies.

Table 7.8 Number of Persons Employed and Annual Person Days Worked by Activity (After the Project) - Control Area

Activities	Average employment			Annual person-days employed		
	Family	Hired	Total	Family	Hired	Total
Rice milling	1.5	0.5	2.0	276	92	368
Cane bamboo products	3.0	-	3.0	675	-	675
Net making	-	-	-	-	-	-
Furniture making	2.0	2.0	4.0	480	480	960
Tailoring	1.5	0.5	2.0	339	113	452
Carpentry	2.0	-	2.0	500	-	500
Blacksmithing	2.0	-	2.0	234	-	234
Rickshaw pulling	-	-	-	-	-	-
Boatmen	1.7	0.3	2.0	357	63	420
Rice trading	1.0	-	1.0	180	-	180
Grocery/Stationery	2.0	-	2.0	360	-	360
Vegetable trading	1.0	-	1.0	200	-	200

Source: PIE Case Studies

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

Item	Area	% of enterprises reporting			Actual change (%)
		Increase	Decrease	Same	
Production	Impacted	43.4	18.8	37.5	+29.4
	Control	33.4	13.3	53.4	-16.3
Income	Impacted	62.4	18.8	18.8	+15.9
	Control	33.3	53.4	13.3	-10.9
Demand for products	Impacted	56.2	18.8	25.0	-
	Control	40.0	53.3	6.7	-

Source: PIE Case Studies

As can be seen from the table, about 43 per cent of the enterprises in the impacted area reported increase in production, and as high as 62 per cent reported increase in their income, compared to the pre-project situation. The actual overall production, of all types of enterprises taken together, also appears to have increased by 29 per cent in the impacted area, as against 16 per cent decline in the control area. As regards income, again the enterprises in the impacted area have experienced an increase by 16 per cent, as against a decline of 11 per cent in the control area. About 56 per cent of enterpreneurs in the impacted

area mentioned that demand for their products has increased, as against about 40 per cent of the enterprises reporting increase in demand in the control areas.

Table 7.10 presents information on annual income per enterprise, as at present, from various non-farm activities. Since the enterprises under study widely vary in capital, scale and employment, the annual figures are standardised through obtaining return per family labour unit of the enterprises, shown in the last column of the table. The table indicates that compared to the control areas, income per family labour unit for most of the activities is higher in the impacted areas, except for boat transport and carpentry.

7.7 PERCEPTIONS OF BENEFITS FROM THE PROJECT

During the case study, the entrepreneurs' perceptions of benefits from the Project were recorded. The perceptions of benefits for development of non-farm activities are presented in Table 7.11. As can be seen from the table, 7 out of 16 (i.e. 44 per cent) of entrepreneurs in the impacted area mentioned that they have benefited from the Project. Enterprises appear to have benefited by way of easier transportation, increased supply of raw material and increased demand for output.

Table 7.10 Per Enterprise Annual Return of Various Non-farm Activities

Activities	Per enterprise annual family income		Annual income per family labour	
	Impacted	Control	Impacted	Control
Rice milling	101600	52495	50800	34997
Cane bamboo products	19066	19945	5778	6648
Net making	17720	NA	5907	NA
Furniture making	NA	26240	NA	13120
Tailoring	25000	14875	25000	99160
Carpentry	32600	28500	10867	14250
Blacksmithing	50400	15150	50400	7575
Rickshaw pulling	17720	NA	17720	NA
Boatmen	12282	15650	7225	9206
Rice trading	24450	22240	12225	22240
Grocery/Stationery	24520	17040	24520	8520
Vegetable trading	15880	5000	7940	5000

Source: PIE Case Studies

Table 7.11 Respondents' Perceptions of Benefits from the Project

Type of benefit	% of benefited respondents
Eased transportation of raw material and output	100.0
Increased supply of raw material	100.0
Increased demand for output	100.0
Others	42.9
Benefited respondents	7
Benefited respondents as % of total	44

Source: PIE Case Studies

7.8 DAMAGE BY 1988 FLOOD

Table 7.12 gives information on type and extent of damage caused to enterprises by the 1988 floods. As can be seen from the table, out of 16 enterprises in the impacted area, 11 (i.e. 69 per cent) suffered losses, as against 9 out of 15 (i.e. 60 per cent) in the control area. So far as damage to infrastructure and industries are concerned, the Project appears to have not had a significant impact. The extent of loss caused per enterprise is higher inside the project (Tk.4000 per enterprise) than in the control areas (Tk.2400 per enterprise). This may be because those inside the protected areas had established their enterprises on lands that they believed were not at risk, whereas enterprises outside tended to build on higher grounds in the absence of protection from probable floods. It is also likely, however, that the higher losses are a reflection of the greater economic growth in the impacted area, which will have increased the value of assets at risk.

Table 7.12 Damage Caused by 1988 Flood

Area	Total Sample	No. of units affected by 1988 flood	%	Per enterprise[1] amount of damage on account of (in Tk)					
				Structure	Machinery	Raw material	Output	Working days	Total
Impacted	16	11	69.0	2100	25	272	519	1055	3971
Control	15	9	60.0	753	67	740	487	387	2434

Source: PIE Case Studies
Note: [1] averaged over all enterprises.

8 SOCIO ECONOMIC IMPACTS

8.1 BACKGROUND

In the pre-project period about 90 per cent of households were poor, comprising landless, marginal farmers and small farmers, while only 10 per cent of households fell in the medium and large farmer categories. Farming, wage labour, fishing and boat plying were the main occupations of the people. Remittances from abroad were a useful source of income. Because local agricultural productivity was low, due to damage by floods, landless wage labourers used to migrate to distant areas such as Sunamganj and Chhatak during the Boro and Aman harvest seasons.

Transport and communication systems were very poor. There were social conflicts over the leasing of the haor for fishing, but no serious feuds or violent clashes were reported.

The Project had no explicit objectives in terms of social development or income distribution. The baseline survey of Zilkar Haor Project (Ahmed 1984) expected that the direct benefits of increased agricultural production, employment and incomes, and a consequent improvement in road communication, education facilities and farmers cooperatives, would result in overall socio-economic development.

8.2 DEMOGRAPHIC CHARACTERISTICS

The demographic characteristics of the study areas are shown in Table 8.1. In interpreting the table, it should be noted that the 'others' category is a non-random sample of households in other occupational categories, and that the 'labourer' category is strictly non-cultivating households but comprising almost entirely of labourers.

The average family size varies between 6 and 8, the labouring households having slightly smaller family size than the other categories of households. The households of different categories in the impacted areas have generally higher dependency ratios, compared to control areas, but which may be related to higher household incomes due to the Project. The households in the impacted area have a higher proportion of literate heads compared to the control areas, but the Project does not appear to have created any significant impact on the enrolment of school age children. However, the labourer and fishermen households in the impacted area have a higher proportion of girls attending school, compared to those in the control areas.

Table 8.1 Demographic Characteristics of the Households in Zilkar Haor Project

Characteristics	Farmer		Labourer		Fishermen		Others	
	Impacted	Control	Impacted	Control	Impacted	Control	Impacted	Control
Family size	8.8	7.4	6.2	6.2	6.8	7.5	7.1	7.6
Sex - ratio[1]	105	131	98	94	100	97	97	117
Independency ratio[2]	4.2	3.4	4.0	4.0	3.8	3.4	3.6	3.7
% literate hh heads	42	26	17	13	31	7	55	53
% children attending school (Boys)	58	68	22	38	34	29	53	84
(Girls)	53	53	33	15	38	10	67	78

Source: PIE Survey, 1991.

Note: [1] Number of males per 100 females

[2] Number of non-earners per person engaged in income generating activities (i.e. domestic cost saving activities counted as 'dependent').

8.3 OCCUPATIONS AND EMPLOYMENT

8.3.1 Household Occupation

The average number of earners per household is in general lower in the impacted than in the control area. There is greater involvement in secondary occupations in the impacted area than in the control area and the farming households tend to have a greater involvement in secondary occupations than labour households (Table 8.2). It is noteworthy that the fishermen's households tend not to have a second occupation.

Table 8.2 Occupations of households in Zilkar Haor Project

Criteria	Farmer		Labourer		Fishermen		Others	
	Impacted	Control	Impacted	Control	Impacted	Control	Impacted	Control
No. of earner per hh	2.07	2.17	1.54	1.56	1.81	2.10	2.00	2.07
% hh head with 2nd occupation	23	19	15	9	6	0	100	100
Incidence of pry occu.[a]	37(85)	11(90)	18(71)	12(66)	3(90)	7(85)	8(80)	7(78)
Incidence of second. occu.[b]	50(20)	25(20)	13(21)	4(11)	3(10)	0(-)	25(63)	16(52)

Source: PIE Survey, 1991.
Note: [a] Figures in the parentheses indicate percentages of earners who are involved in the major source of income
[b] Figures in the parentheses indicate percentages of earners who have a secondary occupation.

8.3.2 Occupational Changes

There appears to have been a tendency for the proportion of farmers with farming as the main occupation to increase in the post-project period. The increase was relatively more pronounced in the impacted/protected area (Table 8.3). This may be a result of farming having become more profitable due to better flood control. In Zilkar Haor Project, there has been greater occupational mobility in the Project areas than in the control areas. The RRA revealed that about 25-30 per cent of cultivated land in the post-project period was under sharecropping, which is higher than reported for the pre-project situation.

As regards negative impacts of the Zilkar Haor Project, the construction of the Badaghat-Noagaon full flood embankment and Lamakazi-Noagaon bunds led to a significant decrease in employment and income of boatmen and boatmen-cum-fishermen. The PIE survey data show that the number of boatmen has decreased in the protected areas but has increased to some extent in the control areas. The most adversely affected boatmen are those whose incomes from the collection of boulders and coarse sands (from the hill side locations such as Bholagonj) have been reduced as the embankment obstructs boats from plying across the haor.

Table 8.3 Main Earners' Main Occupation before and after the Project, Zilkar Haor

Occupation	Impacted				Control	
	Protected		Unprotected			
	Pre	Post	Pre	Post	Pre	Post
No households	96	96	70	70	80	80
Cultivator (%)	67	73	76	74	76	79
Agri. Labour (%)	22	22	19	21	20	21
Fisherman (%)	1	1	0	0	0	0
Transport (%)	0	0	0	0	0	0
Trade (%)	1	1	1	1	0	0
Salaried service (%)	6	1	1	1	1	0
Nonfarm labour (%)	2	2	1	1	1	0
Non-earning (%)	1	0	1	0	1	0

Source: PIE Survey, 1991.

The improvement in year-round road communication has generated self-employment opportunities in petty trading. Occasional repair of kutcha roads has provided some employment for the poorer households. The improved road communication provided by the embankment, and partly by internal road construction under FFW programmes, has facilitated government and non-government development activities such as those of Friends in Village Development in Bangladesh (FIVDB) engaged in income generating activities for poor men and women.

8.3.3 Employment Changes

The direct employment impact of the Project has resulted from the construction and maintenance of the embankment, the sluice gates and irrigation inlets. The poor households (both cultivators and non-cultivators) within and adjacent to the Project have benefited from such work.

The increased production of paddy has also led to some increase in crop sector employment, which accrues to both family and hired labour. However, the agricultural labour households interviewed reported that they got 154 man-days of work in the impacted areas as against 202 man-days in the control areas (Table 8.4). Hence, any benefit from the Project has failed to catch up with employment in the control areas. Although there are variations in the number of days worked by months by agricultural labourers, there is no significant variation in wage rates between months. A more important finding is that the wage rates are in general slightly lower in the control area than in the impacted area, adding support to the supposition of increased agricultural employment.

Table 8.4: **Level of Employment and Wage Rates of Agricultural Labour Household Head by Months in Zilkar Haor, 1990-91**

Months	Days employed per respondent		Average wage rates (Taka)	
	Impacted	Control	Impacted	Control
Baisakh	22.64	24.25	50.18	46.26
Jaistha	17.36	20.04	49.03	42.86
Ashar	5.80	11.33	48.35	42.39
Sravan	5.58	14.83	46.50	45.16
Bhadra	17.09	25.71	47.34	48.13
Aswin	9.93	13.29	47.43	46.21
Kartick	5.80	7.75	48.29	48.43
Agrahayan	22.53	26.75	49.87	48.26
Poush	14.51	18.00	49.40	45.86
Magh	13.13	14.17	47.55	47.77
Falgoon	8.51	12.00	46.81	47.11
Chaitra	7.87	14.00	47.40	44.00
Total	153.75	202.12		

Source: PIE Survey, 1991.

As regards migration of labour, the RRA findings showed that there had been a 20-25 per cent reduction in seasonal out-migration of labourers, perhaps as a result of increased output and employment from paddy production.

8.4 INCOME DISTRIBUTION

The households in the impacted villages had 43 per cent higher income per household, 52 per cent higher income per person and 68 per cent higher income per earner, than households in the control villages (Table 8.5). One major reason for such large differences in average income is that the control area suffered severe flood damages to the Boro crop in the year of investigation. Table 8.5 also shows that the differences in average income were not uniform across different landholding categories, with larger landholding households having proportionally greater differences between the impacted and control areas than those in the smaller landholding groups. The average incomes per households were more unequal in the impacted villages than in the control villages, and the ratios between incomes of the lowest and the highest landholding categories were estimated to be 1:6 and 1:2 respectively for the impacted and control villages. In particular non-cultivating households, which are predominantly dependent on wage labour, have about 13 per cent lower incomes in the

impacted area compared to the control area, though the income per person in the impacted area is 18 per cent higher.

Table 8.5 Household Income by Landholding Category Zilkar Haor
(Tk. in 1990-91)

Landholding	Impacted				Control			
	No. hh	Tk/hh	Tk/person	Tk/earner	No. hh	Tk/hh	Tk/person	Tk/earner
≤ 20d	40	13095	1527	6021	21	15089	1298	4592
21-100d	37	17408	1946	7237	14	33980	2918	8976
101-250d	40	31170	4375	15204	18	13881	2015	5949
251-500d	26	39841	3865	14190	19	27472	3434	12428
501-750d	14	68547	5422	21811	4	9049	770	2784
+750d	9	83379	4841	20845	4	29859	1991	10858
All hh	166	30718	3310	12556	80	21500	2175	7479

Source: PIE Survey, 1991

The bulk of the benefits of the project clearly went to landowners, especially to larger landowners. The PIE survey shows that those with over 0.4 ha of land in the protected area had significantly higher per capita incomes than those in the control area.

A further disaggregation shows that the farming households as a whole were much better off in the impacted area than in the control area. Table 8.6 shows that cultivation provided the single largest source of household income in the impacted villages, while in the control villages, which had experienced heavy flood damage in the year investigated, a substantial proportion of household incomes came from 'salary incomes' including large remittances from family members working overseas. The same table also shows that incomes from wage labour constituted a higher proportion of total income in the control area, compared to the impacted area. This may imply that small farmers in the Project area are engaged in more intensive cultivation and so have less opportunity to work further afield, or have less need to supplement their incomes by working as wage labourers for others.

8.5 LANDHOLDING AND LAND ACQUISITION

8.5.1 Land Holdings

The PIE survey data relating to sale and purchase of land reveal more upward mobility in landholding in the impacted area than in the control area. Table 8.7 shows that 13 per cent of households in the impacted area (cultivating and non-cultivating households) increased landholding size, as against 5 per cent of households in the control area. On the other hand, the land holdings of 32 per cent of households in the impacted areas have decreased since the Project, whereas in the control area 36 per cent households have experienced a decrease in landholding (Table 8.7). In both the impact and control areas a substantially higher

proportion of households lost rather than gained land but there were more losers and fewer gainers in the control. The ratio of area sold to area purchased was larger in the control area compared with the impacted area (Table 8.8). Taking the landholding categories used in Section 8.4 as marking an important distinction between levels of household income and wealth, it is notable that 18 per cent of households in the protected area changed between landholding categories in this short period, whereas only 9 per cent of households in the control area had changed category. The project has induced greater socio-economic change than would otherwise have occurred, widening income inequality.

Table 8.6 Source of Household Income by Landholding Class, Zilkar Haor

a) Impacted area

Landholding	No. hh	Percentage of income from:										
		Cultivation	Trees	Homestead	Livestock	Salaries	Business	Rents	Crafts	Fishing	Transport	Wage labour
≤20d	40	6	7	6	2	0	0	0	5	2	4	67
21-100d	37	49	7	2	3	7	0	1	5	2	0	24
101-250d	40	52	5	1	4	27	4	1	0	3	0	3
251-500d	26	32	7	1	7	43	5	1	1	2	1	1
501-750d	14	39	2	2	4	38	6	4	1	2	0	1
+750d	9	56	2	1	6	25	1	3	0	2	1	0
All hh	166	41	5	2	4	27	3	2	2	2	1	11

b) Control area

Landholding	No. hh	Percentage of income from:										
		Cultivation	Trees	Homestead	Livestock	Salaries	Business	Rents	Crafts	Fishing	Transport	Wage labour
≤20d	21	2	11	5	6	2	0	0	2	3	1	68
21-100d	14	8	5	2	1	58	3	0	0	4	0	18
101-250d	18	30	13	3	15	4	0	1	1	8	1	26
251-500d	19	32	12	1	12	21	6	1	2	5	1	6
501-750d	4	-22	13	18	-1	83	0	0	0	9	0	0
+750d	4	-1	11	3	10	74	0	2	0	3	0	0
All hh	80	16	10	3	8	30	2	1	1	5	1	23

Source: PIE Survey Reports.

Table 8.7 Number of Households Experiencing a Change in Landholding Since the Project

Change in Land	Impacted (Protected)	Impacted (Unprotected)	Control	Total
Increase	14(14.6)	8(11.4)	4(5.0)	26(10.6)
No change	47(49.0)	44(62.9)	47(58.8)	138(56.1)
Decrease	35(36.5)	18(25.7)	29(36.3)	82(33.3)
Total	96	70	80	246

Source: PIE Survey, 1991.

Table 8.8 Amount of Land Purchased and Sold (dec), Zilkar Haor

Year	Protected		Impacted, unprotected		Control	
	purchased	sold	purchased	sold	purchased	Sold
1986	60	225	-	285	-	-
1987	360	323	-	130	225	322
1988	495	501	412	294	-	460
1989	570	550	205	418	71	104
1990	296	643	73	260	64	539
1991	15	38	18	90	50	71

Source: PIE Survey, 1991.

Table 8.9 shows that the price of irrigated land has risen more in the control areas than in the impacted (protected and unprotected) over the post-project period. However, the price of non-irrigated land has risen more than irrigated land, in the impacted villages, while there has been a decrease in the control area (except for high land).

Table 8.9 Land Price in Zilkar Haor
(Tk./Dec.)

Irrigation Status/Period	Protected			Unprotected			Control		
Irrigated	H	M	L	H	M	L	H	M	L
Pre-project[1]	1142	882	518	1448	1128	886	600	250	262
1991	1249	1034	544	1686	1288	1047	1000	500	190
% Change	+9	+17	+5	+16	+14	+18	+67	+100	-28
Non-irrigated									
Pre-project[1]	1131	742	411	1269	909	507	783	525	353
1991	1644	926	660	1603	933	671	800	521	279
% Change	+45	+25	+60	+26	+3	+32	+2	-1	-21

Source : Community Surveys in PIE Projects.

Note: [1] Approximately 1986
H = Highland, M = Medium Land, L = Low Land

8.5.2 Land Acquisition

The acquisition of land for the construction of new or retired embankments, and for drainage and irrigation channels, has been a major source of dissatisfaction with FCD/I projects in general. In Zilkar Haor such land has been acquired from only 6 per cent of households and on average 0.54 acres of land have been acquired per affected household (Table 8.10). Almost the entire land area acquired constituted agricultural land.

Table 8.10 Incidence of Land acquisition

Category	Land Type		Total
	Homestead	Agricultural	
No. of households	1	14	14
% of household affected	0.4%	5.7%	5.7%
Total area acquired (dec.)	22	740	762
Mean per HH with land acquired (dec.)	22	52.86	54.42

Source: PIE Survey, 1991

The payment of compensation was more or less satisfactory as it took about six months to clear up payments, although in 6 out of 14 cases, bribes had to be paid (Table 8.11). The compensation reported to be received (e.g. Taka 218 per 0.01 acre) was much lower than the prevalent market price of land (see Table 8.9). Although the affected people expressed some dissatisfaction about land acquisition, they knew that the compensation was fixed on the basis of land prices quoted in the legal deeds of the most recent years, which were by and large undervalued in order to evade government taxes.

Table 8.11 Payment of Compensation for Acquired Land, Zilkar Haor

Indicator	No. of Cases	Average land owned dec/hh	Average land acquired dec/hh	Total land acquired dec.	Compensation			Mean Bribe paid Tk/dec
					Average per case	Average per dec.	Average time	
Not compensated[1]	4	920	38.75	155	-	-	-	-
All compensated	10	129	60.9	607	13300	218	6.2	?
Compensated bribed	6	138	68.66	412	9166	133	6.33	5
Compensated not bribed	4	116	48.75	195	17000	349	6.0	-
All cases	14	355	54.4	762	-	-	-	-

Source: PIE Survey, 1991
Note: [1] Donated land

8.6 INVESTMENT AND QUALITY OF LIFE

8.6.1 Non-land Assets

In Zilkar Haor Project, where there have been considerable financial gains, some investment in improved housing has taken place. More houses were in good condition, and the incidence of pucca and corrugated tin roofed houses was higher, than in the control area (Table 8.12). There was no perceptible difference in water and sanitation facilities between the impacted and control areas.

As regards other non-land asset ownership, the incidence of ownership of fishing nets and boats among non-fishermen households is far lower in the impacted areas than in the control area. This presumably reflects the negative impact of the project on the floodplain open water fisheries (Chapter 5).

8.6.2 Credit

The reduction of flood risks may have encouraged farmers to take loans. The PIE survey shows that 58 per cent of cultivators and 65 per cent of non-cultivators in the impacted villages (protected plus unprotected) took loans for cultivation and other purposes, compared to 26 and 13 per cent respectively in the control areas. The average loan per cultivator borrower in the impacted village was also 80 per cent higher than in the control villages (Table 8.13). However, the unprotected impacted area has benefited little from the Project and so it may be that access to credit is better for reasons unrelated to the Project.

Table 8.12 Percentage of Households by House Type, Zilkar Haor

Construction Type (Main room)	Impacted		Control
	Protected	Unprotected	
Pucca	5	4	1
Pucca wall	15	6	5
CI Wall and roof	4	4	1
Mud Wall/Tile roof	13	16	6
Thatched wall/Tile roof	42	39	34
Thatched wall and roof	22	31	53
Condition of Main House			
Good	22	14	5
Fair	50	43	49
Bad	27	43	46
Invested in New Construction			
Major repair	32	40	25
New Room	19	11	6
Both repair and new room	1	1	4
No investment	48	47	65

Source: PIE Survey, 1991.

Table 8.13 Credit Use During 1990-91, Zilkar Haor

	Protected		Unprotected		Control	
	Farmer	Non-cultivator	Farmer	Non-cultivator	Farmer	Non-cultivator
No. hh	70	26	50	20	57	6
% hh receiving loan	54	65	64	65	26	13
Mean loan (overall hh)	5531	1342	3453	2250	2544	304
Percentage use of loans						
Cultivation	6	0	16	0	7	0
Livestock	9	0	1	0	1	0
House repair	2	4	3	3	6	10
Necessities	69	96	78	97	79	71
Social function	14	0	2	0	7	19

Source: PIE Survey, 1991.

8.7 FLOOD IMPACTS

8.7.1 Incidence of Floods

The average number of flood years over the 10 year period since completion of the Project was more or less the same for the Project and control areas (Table 8.14).

Table 8.14 Incidence of floods before and after the Project.
(No. of Mouzas affected)

Incidence	Protected	Unprotected	Control
Pre-Project			
Every year	6 (67)	1 (25)	2 (33)
Some years	2 (22)	2 (50)	1 (17)
Rare	-	1 (25)	-
No flood	1 (11)		3 (50)
Post-project			
Flood	10	4	3
No flood	-	-	-
Av. no. of flood years	3.0	3.5	2.3

Source: PIE Survey, 1991
Note: Figures in parentheses indicate percentage of mouzas reporting given frequency.

8.7.2 Crop Damages by 1987 and 1988 Floods

The PIE survey reveals that the embankment could not protect the Project areas from extreme floods such as in 1987 and 1988. The damage to crops caused by these floods, however, was reportedly significantly less in the protected area than in the control area (Table 8.15). Moreover, the embankment sections, and the Lamakazi-Noagaon bund which divides Zilkar Haor from Haparu Haor, provided shelter to humans and animals. This is certainly an unintended but positive impact of the Project.

8.7.3 Other Household Flood Damages

While the most recent homestead flooding for most households in both impacted areas and the control area was in 1988, there has been some limited homestead flooding in the three subsequent years. Average depth and duration of flooding in the homesteads did not differ in a given year between protected, unprotected, and control areas, and if anything floods were slightly less severe inside the Project. However, Table 8.16 shows that in almost all cases, the losses reported were higher in the protected area, particularly in the most important flood year (1988). This may reflect higher wealth of the Project area, with better quality

houses and hence higher damage, as has been argued in Chapter 7 for the similar case of business losses.

Table 8.15 Percentage of Normal Yields Achieved in Zilkar Haor

Crops	1987			1988		
	Protected	Unprotected	Control	Protected	Unprotected	Control
B. Aman	58	31	38	0	9	9
L.T. Aman	79	68	68	18	31	22
HYV Aman	48	-	13	9	-	-
B. Aus	59	13	52	11	-	17
HYV Aus	58	49	17	14	28	5

8.8 LOCAL PARTICIPATION, OPINIONS AND SOCIAL CONFLICTS

There was a reasonable level of consultation between BWDB and local people at the planning and implementation stages of the Project in relation to acquisition of land, alignment of the embankments, construction of sluice gates, and provision of pipe inlets for irrigation. As a result, this appeared to be one of the Projects where local knowledge about the physical and social features of the Project area had been utilized. However, this was not enough to remove doubts about the usefulness of the Project, because there were many stories heard about unsuccessful flood control projects around this area. A number of households from both the protected and unprotected villages expressed doubts about the Project, but few of them actually protested against its implementation (Table 8.16). The community surveys revealed that only 5 out of 14 impacted villages expressed such doubts. Three of these five villages expressed general dissatisfaction, while in the other two, there were feuds between rival factions, centred around local influential people and Union and Upazila Parishad representatives who were the main initiators of the Project.

The Project has clearly led to conflicts of interest, particularly between farmers and fishermen about the time of draining out of water from the haors, and between farmers and boatmen (the latter used to earn income from transporting boulders across the haors). However, such conflicts could also be locally resolved because the beneficiaries of the Project, especially the larger landowners, could see the positive tangible benefits already created.

The opinions from the protected households show that the major benefits expected from the Project were flood protection for crops and homesteads, and an improvement in road communication.

The major disbenefits from the Project apprehended by the respondents were water logging (72 per cent of households), pollution of waterbodies (44 per cent of households) and loss of open water capture fisheries (18 per cent of households).

There is wide agreement between the quantitative estimates of benefits and respondents' perceptions of benefits and disbenefits accruing to different income groups. In

Zilkar Haor Project it was mainly farmers, especially large landholders, who benefited most. The labour households, fishermen and boatmen were mentioned by the respondents as the main disbenefited groups.

Table 8.16 Mean Non-crop Damage per Affected Household (Tk), Zilkar Haor

Year	Protected	Unprotected	Control
1988	5437	2389	1586
1989	3143	1925	3000
1990	3733	1504	567
1991	913	1050	3100
Percentage of flooded households reporting non-crop damage			
1988	81	84	75
1989	100	100	50
1990	86	100	43
1991	89	67	100

Table 8.17 Conflicts over Project Implementation, Zilkar Haor

Whether households doubted usefulness of project and measures taken	Protected		Unprotected	
	Farmer	Non-cultivator	Farmer	Non-cultivator
% of all households with doubts about project	19%	33%	24%	15%
No. of households with doubts	11	5	8	2
% doubting households attempting to prevent project	31%		33%	
Measures taken (no. households)				
Litigation	1		0	
Petitioned BWDB	2		0	
Petitioned DC	1		1	
Protested to local admin.	2		3	
Other action	1		0	

Source: PIE Survey, 1991.

9 GENDER AND NUTRITIONAL IMPACTS

9.1 INTRODUCTION

9.1.1 Limitations

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

9.1.2 The Areas of Investigation

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

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

ii. activities related to homestead production;

iii. nutritional issues;

iv. problems faced by women during severe floods.

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

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

9.2.1 Hiring of Women

In Zilkar Haor, households have been found to be involved both in hiring-in and hiring-out of women for earning an income for the family. Among the farmers, however, hiring-out is extremely rare (Table 9.1) in both impacted and control areas. It may be observed that even among the farmers, the incidence of hiring-in of women is not very high (35 per cent). In contrast to farm households, the labour households rarely hire-in women. The incidence of hiring-out, however, is much higher among them. The fishermen appear to fall somewhere in the middle of the range.

In Zilkar Haor, there has been a substantial gain in paddy production due to the project, creating an opportunity for farmers to hire-in more labour and for labourers to be better employed. It is quite likely that because of such output gains, one finds that the incidence of hiring-in by farmers and hiring out by labourers in the impacted area is much above that in the control. Fishermen do not seem to exhibit any definite pattern.

Table 9.1 : Employment of Women in Out-of-Home Activities
(No. of respondents)

Type of household	Hire in		Hire out	
	Impacted	Control	Impacted	Control
Farmer	22 (35)	6 (20)	1 (2)	0 (0)
Labourer	- (0)	- (0)	10 (50)	1 (14)
Fishermen	1 (8)	- (0)	3 (23)	4 (24)
ALL	23 (23)	6 (11)	14 (14)	9 (9)

Source : FAP 12 PIE Household Survey

Note : Figures parentheses indicate percentages of total number of respondents

9.2.2 Agricultural and Non-Agricultural Work

Women in farm households are involved in various agricultural tasks, particularly those related to crop processing (see below). Very few women from labour and fishermen's households are so involved, since they have little land. The opposite generally holds for non-agricultural work. While very few women from farm households have been found to use their time in non-agricultural pursuits, the proportion appears to be higher in the other categories of households. One also finds that in the Zilkar Haor area proportionately more are involved in non-agricultural work in the impacted area compared to the control. The only exception is the fishermen's households, whose job is non-agricultural in nature, and who are likely to be better employed in the control area compared to the impacted.

9.2.3 Sexual Division of Work in Agricultural Activities

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

The Project did not change the basic pattern of sexual division of work, but the change in output created opportunities for hired women to be employed more in activities like threshing and parboiling in the impacted area (Table 9.2). This did not happen in the control area.

In the post-Project situation the work burden of women fell in case of husking, in which men are now found to be engaged more frequently than before both in the impacted and the control areas. On probing, it has been found that in both cases mechanised husking has become more common than before due to the use of STW engines for the purpose, during the off-season for irrigation. This can only be considered a Project impact to a limited extent

in the Zilkar Haor area, where there is a sharper drop in the husking role of women than in the case of other projects.

Table 9.2 : Sex-wise Role Distribution in Agricultural Work in Farm Households
(percentage of respondents)

Activity type	Impacted						Control					
	F. Women		H. Women		Men		F. Women		H. Women		Men	
	B	A	B	A	B	A	B	A	B	A	B	A
Seed pres.	85.7	87.3	4.8	11.1	41.3	38.1	90.0	90.0	-	3.3	23.3	23.3
Pre-harvest	-	-	-	-	100.0	100.0	-	-	6.7	-	90.0	90.0
Harvest	3.2	3.2	-	-	96.8	96.8	3.3	3.3	6.7	-	86.7	86.7
Threshing	58.7	60.3	7.9	20.3	54.0	52.4	56.7	56.7	10.0	6.7	56.7	56.7
Parboiling	88.9	88.9	19.1	31.7	3.2	4.8	93.3	93.3	16.7	16.7	-	-
Husking	58.7	44.4	14.3	9.5	6.4	23.8	70.0	63.3	6.7	6.7	16.7	30.0
Storage	95.2	98.4	4.8	19.0	7.9	7.9	96.7	96.7	6.7	6.7	3.3	3.3

Source : FAP 12 PIE Household Survey

9.2.4 Change in Agricultural Activities of Women Family Members and Reasons Thereof

Several factors may influence the direction and magnitude of change in the work burden of women in agricultural activities. A rise in output, which is the case in Zilkar Haor impacted area with an estimated 90 per cent or so increase in paddy production, will demand more of the time of women in most of the activities they are engaged in. The actual outcome in case of women from the family will, of course, depend on how much of the additional load is shared by either men or hired women labourers. There is no *a priori* hypothesis about such substitution and the final outcome may therefore be judged empirically.

The information from Zilkar Haor area indicates that the situation is rather mixed. In the impacted area, except in seed preservation, more women appear to have experienced a decreasing work load than those who have experienced an increase (Table 9.3). In parboiling, husking and storage those who claimed a decreasing load outnumber those who experienced an increase. The only redeeming feature appears to be that in the impacted area some have claimed an increase while none did so in the control. The data from Zilkar Haor area clearly demonstrate that project impact on employment of women, even when there is a substantial change in output, may not be easily identified.

Among those who could identify the reasons for the change in the impacted area, practically all ascribed it to higher output (Table 9.4). Only a few could clearly identify the reasons for decrease, but among those who did so, the problems created by flood, water logging and excessive rain were most important.

Table 9.3 : Changes in Activities of Family Women in Agricultural Operations
(No. of respondents)

Activity type	Impacted		Control	
	Increased	Decreased	Increased	Decreased
Seed pres.	12	9	0	0
Pre-harvest	0	0	0	0
Threshing	9	10	0	0
Parboiling	18	32	0	17
Husking	3	18	0	11
Storage	12	19	0	12

Source : FAP 12 PIE Household Survey

Table 9.4 : Reasons for Change in Women's Involvement in Agricultural Activities in Farm Households
(No. of responses)

Reasons	Impacted	Control
A. *Increase*	30	1
Higher output	27 (90)	1 (100)
Others	3 (10)	-
B. *Decrease*	10	2
Flood/water logging/rain	10 (100)	2 (100)
Land loss		
Cut in emb.		
More husking machines		
Pest attack		
Lower yield	-	-
Others		

Source : FAP 12 PIE Household Survey

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

9.3 HOMESTEAD PRODUCTION

9.3.1 Number and Types of Trees

The average number of trees per household (including bamboo) has fallen in both the impacted and control areas, but more so in the latter (Table 9.5). The number of trees per household is the highest among the farmers, as they have more land compared to others in and around the homesteads. In their case also there is a diminution in the average number of trees compared to the pre-Project situation but again more so in the control area. Labour households show a similar pattern. It is only among the fishermen's households that the relative reduction is higher in the impacted area.

It is difficult to explain the differences between the impacted and control areas and among the occupational groups without additional information. However, it may be noted that in the impacted area, the rate of felling of trees may be lower than in the control, due to an increased level of output and employment opportunities for labour households. On the other hand as fishermen are somewhat better-off in the control area than in the impacted, the pattern should be the opposite to that found in other types of households.

Many types of trees are grown in the homesteads. One may categorise them however, as fruit-bearing or timber-yielding. The data from Zilkar Haor indicate that there may have been little change over time in the proportion of the former (from 29 per cent to 32 per cent in the impacted and 38 per cent to 42 per cent in the control).

Table 9.5 : Average Number of Trees in and Around Homesteads

Household type	Impacted		Control	
	Before	After	Before	After
Farmer	230	140 (-39)	184	91 (-51)
Labourer	147	68 (-54)	85	25 (-70)
Fishermen	42	13 (-69)	125	67 (-46)
ALL	186	107 (-43)	153	75 (-51)

Source : FAP 12 PIE Household Survey

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

9.3.2 Sexual Division of Work in Caring for Trees

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

What may have happened over time in the relative roles of men and women in caring for trees is difficult to assess, but it may be noted that the percentage distribution of fruit-bearing trees has remained unchanged while the average number of trees (of all types) has gone down. This indicates that over time, the work burden of women in general tree-care may have fallen, as it is the fruit-bearing trees which demand more attention of the tree-owners. On the other hand, however, as the demand for fuel wood per household may at best have remain unchanged if not increased, it may mean more time spent in collection and gathering of fuel wood outside the home, unless purchases are made to close the shortfall in supply from within the homestead.

In actual decision making the process seems more participatory. Even in tree-felling 35-40 per cent of women have participated across all the groups (Table 9.6). In other types of decision making not only is the proportion of women participating much higher, but also in decisions like harvesting a sizeable proportion of them make decisions alone without any reference being made to men.

Table 9.6: Incidence of Women's Role in Decision-making in Tree Plantation
(No. and % of women responding positively)

Type of household	Plantation		Harvesting		Tree-felling	
	Imp	Cnt	Imp	Cnt	Imp	Cnt
Farmer	46 (78)	13 (45)	52 (91)	24 (83)	24 (41)	7 (24)
Labourer	13 (81)	1 (17)	15 (94)	6 (100)	6 (38)	0 (0)
Fishermen	2 (28)	12 (92)	6 (86)	13 (100)	2 (28)	9 (69)
ALL	61 (74)	26 (54)	73 (91)	43 (90)	32 (40)	16 (33)

Source : FAP 12 PIE Household Survey

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

9.3.3 Vegetable Production : Incidence and Sex Roles

Practically all households have a vegetable producing plot, usually quite tiny, no more than 0.01 - 0.02 acres in size. It appears that in the control area there has been some reduction in the area, most noticeably among the farmers (66 per cent over the pre-Project situation). In the impacted area there has been little change in the area so cultivated.

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

9.3.4 Poultry Keeping : Relative Sex Roles

The role of women in decisions regarding poultry keeping does not appear to be prominent except in case of purchase. Also they seem to be more involved in the control area than in the impacted area. This may be a reflection of the greater diversity of occupation needed for survival in the control area. Lack of further information does not allow a more definitive explanation, however.

9.3.5 Homestead Income and Its Use

The estimated homestead production income per household by type of source and type of household for the impacted and control areas are shown in Table 9.7. The values shown represent respondents' statements of output, valued at local market prices. The overall impression is that the average homestead income is higher in the impacted area compared to the control, except for fishermen who appear to have a much higher income in the control area. There also seems to be some difference in the composition of the income, as respondents in the impacted area seem to receive a considerable proportion of their income in the form of vegetables, while poultry and eggs seem to be the major source in the control area. This seems to bear out the hypothesis that with reduced flood damage, households may be more induced to cultivate vegetables.

Table 9.7 Average Returns from Homestead Production
(Tk./household/annum)

Household type	Impacted				Control			
	Vegetable	Poultry	Egg	All	Vegetable	Poultry	Egg	All
Farmer	1035 (49)	819 (39)	254 (12)	2109 (162)	156 (19)	454 (56)	194 (24)	805
Labourer	226 (47)	160 (33)	97 (20)	483 (65)	105 (36)	51 (17)	137 (47)	293
Fishermen	26 (16)	82 (50)	56 (34)	164 (-89)	485 (33)	534 (37)	430 (30)	1449
All	728 (48)	580 (39)	194 (13)	1503 (60)	253 (27)	427 (45)	261 (28)	941

Source: FAP 12 PIE Household Survey

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 the source by area and type of household.

One may also notice that it is the farmers who may have gained most from homestead income. There may be several reasons for this. They can grow vegetables on comparatively larger plots of land, and they can also keep more chickens and ducks which although basically scavengers may still be better fed and cared for because of the higher agricultural output in the farm households. Then again, women in farm households being freed of the back-breaking job of paddy husking, may have more time for such activities, while women in other, particularly labour households, though similarly freed may have to look for other jobs.

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

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

9.3.6 Group Activities

Very few women were found to be involved in group activities. Those who had been are mostly from fishermen's households in both the impacted and the control areas.

9.4 NUTRITIONAL ISSUES

9.4.1 Caveats

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

The four types of food mentioned above contribute nearly 84 per cent of total calorie intake (BBS; 1991) in rural Bangladesh. Using this ratio, the total calorie consumption in the sampled households was estimated, as also was protein consumption. It should be noted that the timing of the field work for these investigations may have resulted in seasonal biases in the estimates. Zilkar Haor is mainly a Boro paddy area and the field work there coincided with the latter part of the harvest period. It is quite likely therefore that the estimates made by FAP 12 will show an upward bias.

9.4.2 Food and Calorie Intake

Table 9.8 shows the estimated average consumption of rice and energy on a per capita basis. The most interesting conclusion that one may make is that the control area households are better-off than those in the impacted area on both the counts. Farmers are, however, more fortunate than others in the sense that their consumption of calories is not very different between the impacted and control areas, although the difference in rice consumption appears to be more substantial.

Chapter 8 indicates that the income of farmers is higher in the impacted area compared to the control, while that of labourers is lower. Then again the analyses of changes in agricultural output indicate that there has been substantial output growth (nearly 1 mt) of output per household. Thus while there is a clear reason for the labourer households to have a lower rice and calorie consumption, there is no such clear reason for farmer households. What all these mean is that nutritional well-being is too complex an issue to be analysed in the cursory manner attempted here.

9.4.3 Poverty Profile

The estimated calorie consumptions were used to construct a profile of households on the basis of attainment of threshold levels of calorie intake. The households were divided into three groups, viz., those categorised as hard core poor (consuming at most 1805 Kcal/person/day), absolute poor (consuming between 1805 and 2122 Kcal/person/day) and the non-poor (consuming above 2122 Kcal). The results are shown in Table 9.8.

Table 9.8: Per Capita Daily Rice and Calorie Intake

Household type	Rice (gms)		K calorie	
	Impacted	Control	Impacted	Control
Farmer	540 (-20)	671	2801 (-13)	3209
Labourer	450 (-35)	690	2651 (-19)	3252
Fishermen	607 (0)	607	2976 (-17)	3578
ALL	534 (-18)	653	2798 (-16)	3330

Source : FAP 12 PIE Household Survey

Note : Figures in parentheses indicate percentage differences over control.

These estimates seems to further confirm the finding above, that nutritionally the sample households are better-off in the control area. The proportion of non-poor households is much higher in the control area, but on further scrutiny it seems that it is only the labour households who suffer badly from nutritional poverty in the impacted area compared to the control. In the case of the farmers and the fishermen there is little difference between the two areas in the proportions of the non-poor.

9.4.4 Adequacy of Food Intake

The women were asked about the adequacy of food intake in the family. It does not come as a surprise, given the findings discussed above, that the sense of deprivation is felt more in the impacted area by all groups of households (Table 9.9). The labourers appear to be the most disadvantaged in both areas, and particularly in the impacted area.

9.4.5 Gender Differences in Food Intake

Two indicators of gender difference were used, viz., the difference in rice intake of adult men and women, and that between boys and girls of about 8 years of age. The latter showed little difference in food intake, around 440 grammes per day. In contrast, one finds an appreciable difference between the intakes by adult men and women, the latter having been found to consume 20-30 per cent less than adult men. The deprivation seems to be of similar nature, although slightly lower, in the control area.

Table 9.9 : Distribution of Households by Level of Poverty
(No. of households)

Household type	Hard core		Absolute		Non-poor	
	Imp	Cnt	Imp	Cnt	Imp	Cnt
Farmer	10	1	5	4	49 (78)	22 (83)
Labourer	7	0	2	0	12 (57)	7 (100)
Fishermen	0	0	1	0	12 (92)	17 (100)
ALL	17	1	8	4	73 (74)	49 (91)

Source : FAP 12 PIE Household Survey

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

9.4.6 Consumption of Non-grain Food

A rise in income of the people, one may hypothesise, will lead to an increased consumption of quality foods like meat, fish, eggs and milk, as the income elasticity of such foods is high. Whether this is the case in the Project areas experiencing a substantial growth in output has been tested in a very crude manner by looking at the frequency of consumption of such foods. Table 9.10 shows the incidence of consumption of these types of food over the week preceding the survey. Several conclusions can be drawn. These are as follows:

- fish appears to be the most frequently consumed non-grain food. Most farmers and all fishermen in the impacted area have consumed fish during the reference week. Among labour households, however, only about half of the labour households have been so fortunate. The situation is similar in the control area but slightly worse for the labour households;

- meat and milk appear to be the least frequently consumed food both in the impacted and the control areas but farmers in the impacted area appears to be somewhat more fortunate than those in the control;

- eggs are consumed by farmers and labourers fairly frequently in the impacted area but not so much in the control while among fishermen its consumption is equally infrequent.

The overall conclusion is that farm households have very slightly better non-grain nutrition in the impacted area, but labourers are significantly worse nourished.

Table 9.10 Incidence of Consumption of Non-grain Food During the Last 7 Days

Food type	Farmer		Labourer		Fishermen	
	Impacted	Control	Impacted	Control	Impacted	Control
Meat	21 (33)	7 (23)	2 (10)	1 (14)	1 (8)	2 (12)
Fish	51 (80)	27 (90)	10 (48)	6 (86)	13 (100)	15 (88)
Egg	29 (46)	13 (43)	7 (33)	1 (14)	1 (8)	2 (12)
Milk	15 (24)	7 (23)	1 (5)	1 (14)	0 (0)	1 (6)

Source : FAP 12 PIE Household Survey

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

9.4.7 Frequency of Cooking

Practically all households in both the impacted and the control areas and all groups of households cook at least twice a day. Many also cook three times.

9.4.8 Incidence of Starvation

Despite a rise in annual incomes, people may still starve partly or fully during a part of the year because of seasonal lack of employment and income. When asked about such incidence, the responses seem to indicate that there had been little change in the proportion of households so affected before and after the Project, irrespective of impacted or control areas, for any specific occupational group (Table 9.11). Among the occupational groups, however, as may be expected the farmers are the most fortunate while most labourer and fishermen's households have to starve during parts of the year.

Table 9.11 : Incidence of Starvation in Pre- and Post-Project Situation
(No. of respondents)

Household type	Impacted		Control	
	Before	After	Before	After
Farmer	44 (69)	47 (73)	21 (70)	26 (87)
Labourer	18 (90)	19 (95)	7 (100)	7 (100)
Fishermen	9 (69)	9 (69)	17 (100)	17 (100)
ALL	71 (72)	75 (76)	45 (83)	50 (93)

Source : FAP 12 PIE Household Survey

9.4.9 Seasonality in Starvation

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

In Zilkar Haor, as seen in Chapter 4, the two most important crops are T. Aman and Boro. The incidence of Boro is much lower in the control area (19 per cent of gross cropped area compared to about 45 per cent in the impacted). Aus is conspicuous by its almost total absence. One therefore would expect two dips in the seasonality of incidence of starvation, once right after the Boro harvest and once after and during the aman harvest. The dip in case of Boro may not be prominent in the control area compared to the impacted.

Figures 9.1 - 9.3 confirm the above hypotheses quite well in case of farmers. In case of labourers the dip during Boro occurs somewhat prior to that for farmers which is quite plausible as farmers receive most of their income only after the harvest is over while labourers do so earlier. The impacted-control area differences are clear in case of farmers who receive a substantial part of their income during the Boro season in the impacted area compared to those in the control. As a result, there is hardly any dip in the post-Boro period in the control area although one discerns a possible slackening in the rise of incidence of starvation to the latter.

In case of fishermen, the pattern remains basically the same as for others but with a dip for those in the control during the post-monsoon period.

9.4.10 Adjustment Mechanisms

When the prospects of starvation looms large, people either borrow from others or try to eat less or both (Table 9.12). This is true across all groups of households and in both impacted and control areas. There appears to be a subtle difference in the two areas, however. Those in the impacted area seems to prefer to adjust within the household by eating less while those in the control go more for borrowing. The reasons are not known.

Fig : 9·1

STARVATION IN ZILKAR HAOR

(FARMER)

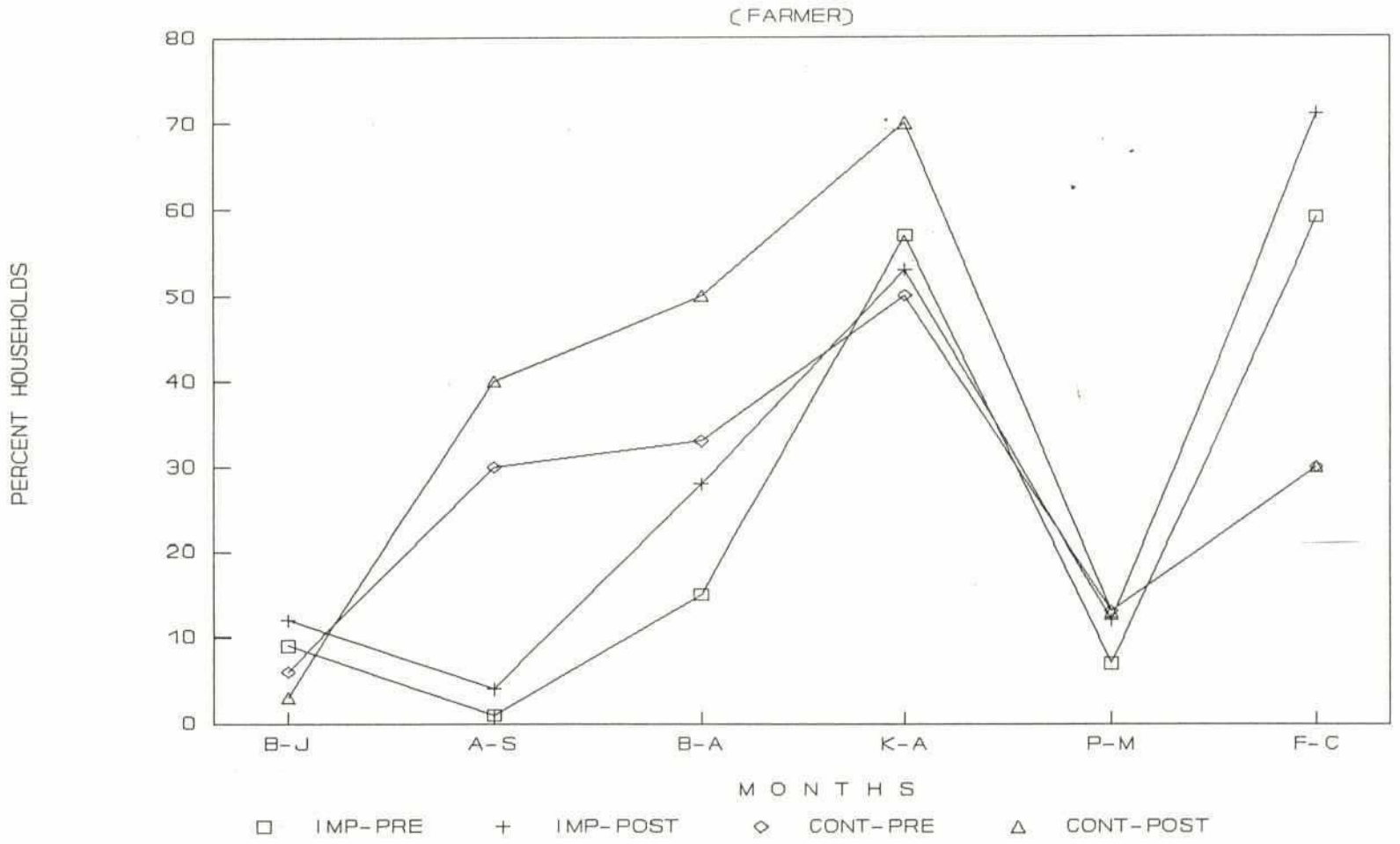


Fig : 9·2 STARVATION IN ZILKAR HAOR

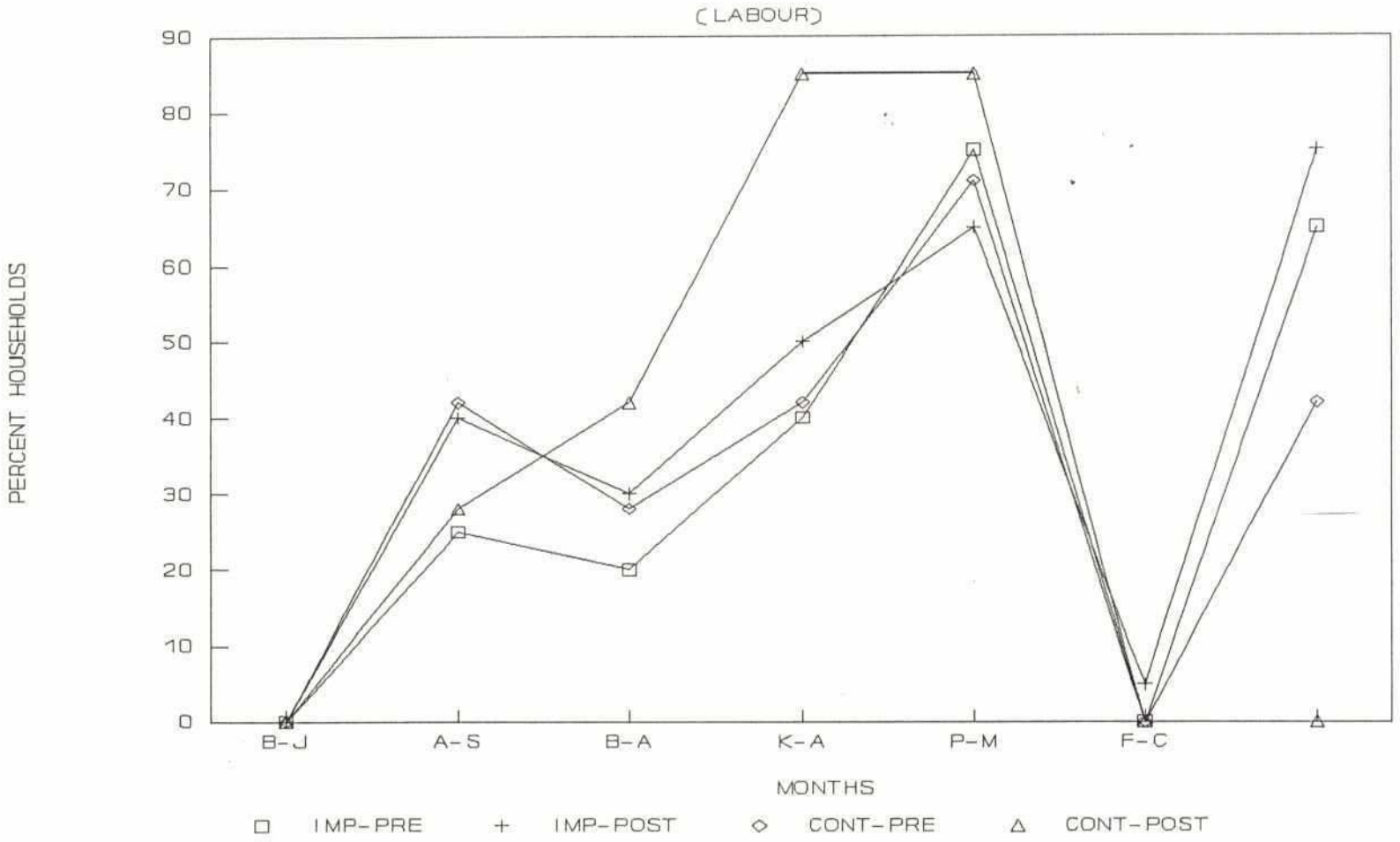


Fig : 9·3 STARVATION IN ZILKAR HAOR

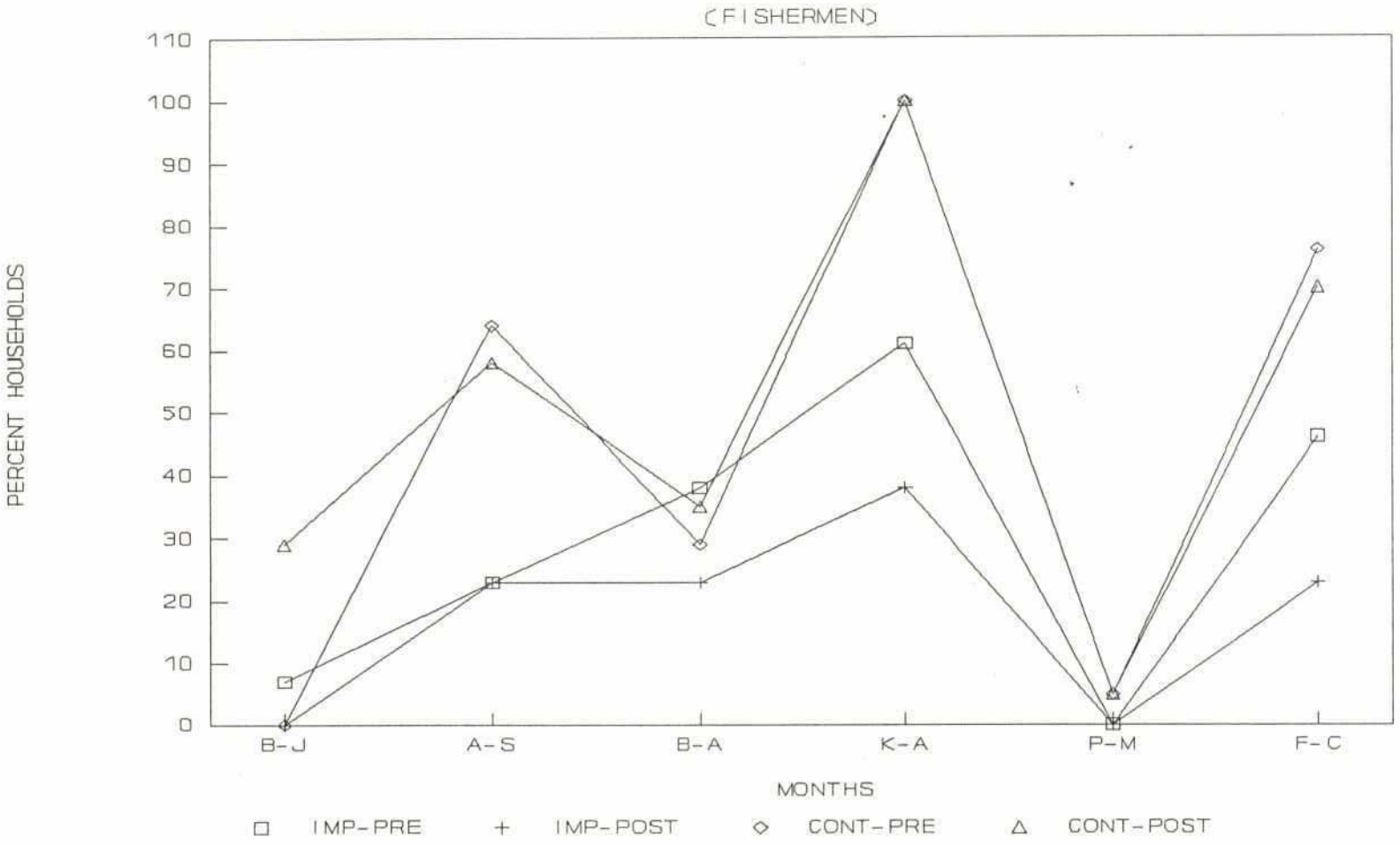


Table 9.12 : Measures to Cope with Starvation
(No. and % of response)

Type of measure	Farmer		Labourer		Fishermen		ALL	
	Imp	Cont	Imp	Cont	Imp	Cont	Imp	Cont
Borrowing	33 (35)	20 (42)	11 (32)	6 (46)	5 (38)	13 (39)	49 (35)	39 (41)
All ate less	24 (26)	9 (19)	14 (41)	3 (23)	6 (46)	8 (24)	44 (31)	20 (21)
Women ate less	15 (16)	8 (17)	3 (9)	2 (15)	2 (15)	5 (15)	20 (14)	15 (16)
Others ate less	4 (4)	-	2 (6)	-	-	1 (3)	6 (4)	1 (1)
Disin-vestment	8 (9)	8 (17)	2 (6)	-	-	2 (6)	10 (7)	10 (11)
Others	9 (10)	3 (6)	2 (6)	2 (15)	-	4 (12)	11 (8)	9 (10)

Source : FAP 12 PIE Household Survey

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

The burden of internal adjustments seems to fall disproportionately on women, and more so in the farm households. In the latter case, while in a quarter of the households in the impacted area everyone in the family shares the hunger, in 16 per cent of cases women alone have to do so. In the control area, however, the proportions are similar but this still means that women still are at a disadvantage. What these findings clearly bear out is that a general rise in the economic well-being in the family may be no guarantee to women's sharing the 'prosperity' equitably with their male counterparts.

9.4.11 Access to Safe Water

Table 9.13 shows the pattern of access to safe water by source and by type of use. The table clearly indicates that in the case of drinking water, while many households depend on safe sources (generally hand tube wells) many still do not, and the percentage of those still relying on unsafe sources (kutcha wells and open water bodies) is generally lower in case of households in the control area. Zilkar Haor area is thus different from the general pattern seen elsewhere, in that here the proportion depending on safe water for drinking purposes is lower than in most other areas.

Table 9.13 : Present Sources of Water by Type of Use
(No. and percentage of total response by category of use by the type of household concerned)

Household type	Area	Cleaning		Cooking		Drinking	
		S	US	S	US	S	US
Farmer	Imp	3 (4.7)	61 (95.3)	10 (15.6)	54 (84.4)	35 (54.7)	29 (45.3)
	Cnt	-	29 (100.0)	2 (6.9)	27 (93.1)	11 (37.9)	18 (62.1)
Labourer	Imp	1 (5.0)	19 (95.0)	2 (10.0)	18 (90.0)	11 (55.0)	9 (45.0)
	Cnt	-	7 (100.0)	-	7 (100.0)	1 (14.3)	6 (85.7)
Fishermen	Imp	-	13 (100.0)	-	13 (100.0)	4 (30.8)	9 (69.2)
	Cnt	-	17 (100.0)	1 (5.9)	16 (94.1)	12 (70.6)	5 (29.4)
ALL	Imp	4 (4.1)	93 (95.9)	12 (12.4)	85 (87.6)	50 (51.6)	47 (48.4)
	Cnt	-	53 (100.0)	3 (5.7)	50 (94.3)	24 (45.3)	29 (54.7)

Source : FAP 12 PIE Household Survey

Note : Figures in parentheses indicate percentages of total number of responses by category of household
S = Safe, US = Unsafe

9.4.12 Problems of Water Quality and Associated Changes

Most women complained about changes in water quality and diseases due to such changes in both impacted and control areas, but the complaints about diseases is less frequent in the control area.

Gastro-enteric diseases are the most widespread among the various types mentioned by women. There is little impacted-control area difference.

9.5 PROBLEMS FACED BY WOMEN DURING FLOODS

Women face many problems during floods. Lack of dry space and toilet facilities create grave difficulties for them (Table 9.14). Other major problems include those of drinking water cooking and food availability. There is little difference between the impacted and control areas, except in the case of shortage of dry space (more acute in the impacted area) and of food availability (more scarce in the control).

Table 9.14 Problems Faced by Women During Floods
(% of respondents - all groups)

Type of problem	Impacted	Control
Dry space	64 (66.0)	25 (47.2)
Drinking water	40 (41.2)	20 (37.7)
Toilet	58 (60.0)	36 (67.9)
Cooking	37 (38.1)	23 (43.4)
Food availability	10 (10.3)	12 (22.6)
Movement	4 (4.1)	-
Homelessness	-	-
No problem	-	-

Source : FAP 12 PIE Household Survey

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

10 ENVIRONMENTAL EVALUATION

10.1 PRE-PROJECT SITUATION

Zilkar Haor FCD/I Project was completed in 1987, following three years of construction. 1991 is therefore the Project's fifth monsoon season, two of which saw the extreme conditions of 1987 and 1988. The embankments were not overtopped, breached or cut, even in those difficult years. The Project has a minor irrigation component, in which controlled inlet pipes in the embankments provide irrigation via low-lift pumps from the rivers during the dry season. There is no roads component.

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 a specific point in time. The main ongoing trend both before and after the Project has been the steady growth in population and the resultant pressure on land and water resources.

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 derived from soil surveys carried out mainly between 1965 and 1977. In Zilkar Haor area, the relevant soil survey took place in 1976.

Zilkar Haor is a small area and pre-Project it was agroecologically straightforward, with a simple pattern of beels in a low-lying basin surrounded by relatively much higher land to the west, south and especially extensive on the east. FAO (1988) included it in their Eastern Surma-Kusiyara Floodplain agroecological region (AER), within which no FAO agroecological subregions (AES) are defined. Two soil associations are mapped by FAO in the Project Area, correlating with the high land (Se 477) and basin (Se 480) respectively. Table 10.1 summarises the FAO classification within the Project Area.

The FAO agroecological classification, therefore, provides a broad spatial framework for environmental assessment both before and after the Project, especially when related to the pre-project flood depths given in Table 10.1. In the Project Area, however, the simple highland-basin pattern mapped by FAO had already been interrupted by the construction of the Gangina cross-bund, running roughly north-south between the Singar and Surma rivers. The aim of this was to pond back water in the higher Haparu Haor for release through cuts into Zilkar Haor during the dry season, where it was used for extensive Boro rice irrigation.

One of the aims of the environmental fieldwork, therefore, was to refine the FAO classification and map further, in order to establish agroecological divisions (AED). The AED are units which relate directly to pre-project (and post-project) environmental conditions (Table 10.1). They are mapped in Figure 10.1 at the FAP 12 map scale here of 1:50,000.

Four AEDs have been defined and are schematically illustrated in Figure 10.1. Pre-project conditions in each are discussed below.

AED A: Haparu High Land

AED A occupies much of the eastern half of the Project Area, covering about 40.5 per cent (2,150 ha) of it. It consists mostly of Medium Highland, with a substantial proportion of Highland and settlements (most of which are also on Highland). Occasional undulations in

the surface create slightly lower areas. Pre-Project flooding ranged from negligible to moderate over most of the AED, which was afforded some protection in the south from the Surma River floods by the Sylhet-Sunamganj main road. In the north, flooding came from the Singar Khal (actually a sizeable river) and on the east the small seasonal Sadi Khal brought floods from both Surma and Singar.

Floods in the Project Area arrived as early flash floods in April-May and again more steadily as higher monsoon flooding in July-August. In addition, however, flooding was also caused or exacerbated by the extremely high rainfall, especially during the monsoon but in some years in earlier months also. Annual rainfall approaches 5,000 mm.

The soils were classified by FAO as Noncalcareous Grey Floodplain Soils (Eutric Gleysols). In AED A there were chiefly silt loams and silty clay loams with acid top soils (pH around 5.0-5.5) and slightly acid to neutral subsoils (pH 6.0-7.0). Organic matter contents of topsoils were 1.5 - 2.0 per cent.

Land use consisted almost wholly of local T. Aman rice, preceded on the higher lands by local T. Aus; some B. Aman or B. Aman-Aus mix was grown in or around the occasional low points. Irrigation was not widely available but where it was, HYV Boro replaced Aus. Trees, including fruit, and limited patches of vegetables and rabi crops were grown in and around the numerous settlements, on the highest lands, usually near the rivers.

Table 10.1 Zilkar Haor: Agroecological Classification

Agroecological Region	Eastern Surma-Kusiyara Floodplain			
Agroecological Subregion	-			
Soil Association	Se 477		Se 480	
Approx. % of Area	59.5		40.5	
Land Types (Flooding - cm)	%		%	
Settlements	20		2	
H (0)	14		0	
MH1 (0-30)	0		0	
MH2 (30-90)	55		1	
ML (90-180)	11		30	
L (180-300)	0		67	
VL (300+)	0		0	
Total	100		100	
Agroecological Divisions (FAP 12)	A	B	C	D
Approx. % of Area	40.5	19	12.5	28

Source: FAO, 1988 and Consultants

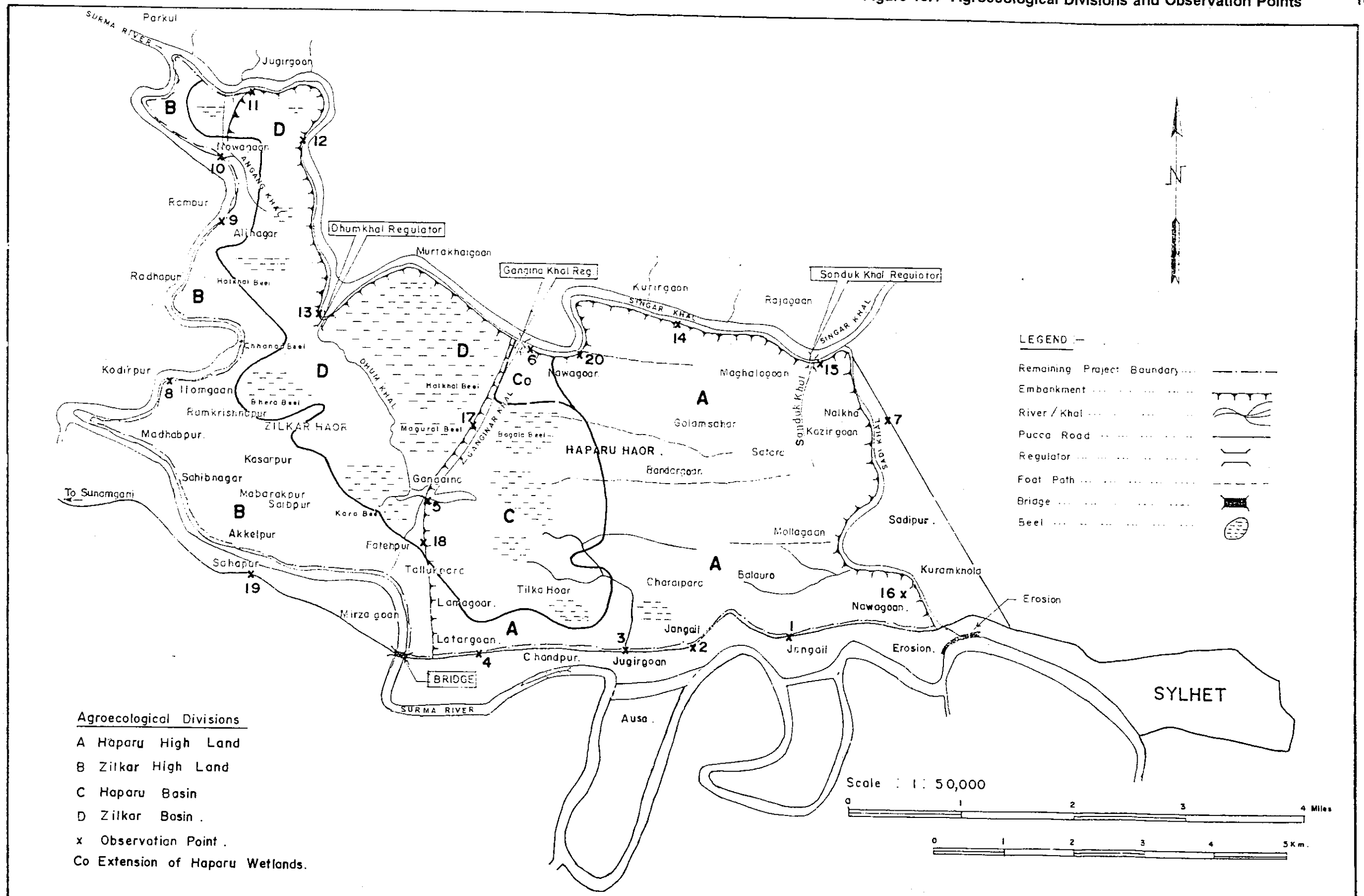
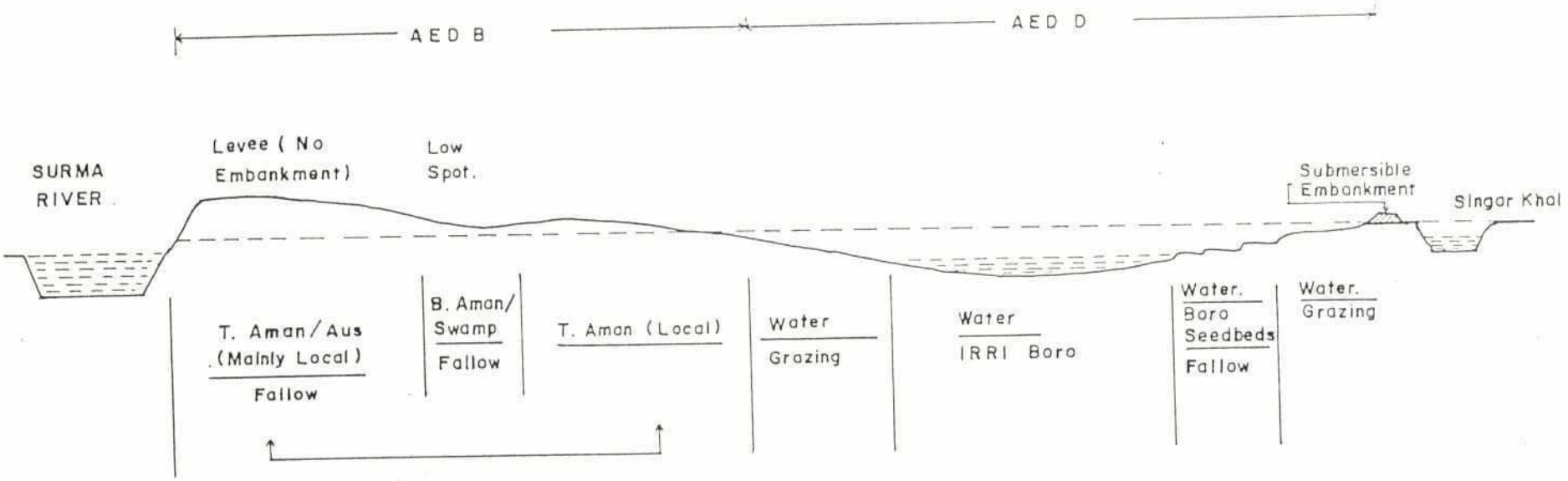

SURMA RIVER
Parkul
Jugirgaon
Nawagaon
ANGANG KHAL
Rampur
Alihagar
Radhapur
Haikhal Beel
Dhumkhal Regulator
Murtakhalgaon
Gangina Khal Reg
Kurirgaon
SINGAR KHAL
Rajagaon
Sanduk Khal Regulator
Kodirpur
Homgaon
Chhanga Beel
Bhera Beel
Ramkrishnapur
ZILKAR HAOR
DHUM KHAL
Magural Beel
Bagala Beel
Madhabpur
Kasarpur
Sahibnagar
To Sunamganj
Mabarakpur
Saibpur
Kora Beel
Gangaino
ZUGANGMAR KHAL
HAPARU HAOR
Satere
Bandargaon
Golamsahar
Maghalagaon
Nalkha
Kazirgaon
Sanduk Khal
SADI KHAL
Sadipur
Akkelpur
Fatehpur
Tallurpare
Sahapur
Lamagaor
Tilka Haor
Charaipara
Balauro
Mollagaon
Kuramkhola
Nawagaon
Erosion
Mirza goan
Latargaon
Chandpur
Jugirgaon
Jangail
Erosion
BRIDGE
SURMA RIVER
Ausa
SYLHET
N
LEGEND
Remaining Project Boundary
Embankment
River / Khal
Pucca Road
Regulator
Foot Path
Bridge
Beel
Agroecological Divisions
A Haparu High Land
B Zilkar High Land
C Haparu Basin
D Zilkar Basin .
x Observation Point .
Co Extension of Haparu Wetlands.
Scale : 1 : 50,000
0 1 2 3 4 Miles
0 1 2 3 4 5 Km.
ZILKAR HAOR, SYLHET

Figure 10.2 Zilkar Haor: Agroecological Divisions (AED)



NOTE :-

AEDs A and C in Haparu Haor fallow a similar pattern to AEDs B and D as shown above. They are, however, protected by a full embankment from the Singar Khal and by the road embankment from Surma River; this means AED A has a higher proportion of HYV T. Aman and can grow some IRRI Boro.

AED B: Zilkar High Land

AED B closely resembled AED A, differing only in lacking the partial protection of the road embankment in the south and having a more peripheral distribution as a narrow band around the western and south-western margin of the basins. As a result of the latter, AED B had less regular relief than AED A, with a rather higher proportion of low spots, in some of which temporary beels formed during the monsoon. The proportion of Highland was also higher than in AED A, formed by a marked natural level along the Surma River.

Thus although FAO included both AED A and AED B in Soil Association Se 477, the proportion of Medium Highland is probably nearer 15 per cent in AED B and only 5 per cent in AED A, while Highland perhaps approaches 20 per cent in AED B and only 10 per cent in AED A. Thus there were rather more deeply flooded patches in AED B, otherwise land use followed the same pattern as in AED A.

Subsequently the Project has imposed different conditions of flood control upon them: AED B is protected only by a submersible embankment in the north, with still nothing on the west and south but the Surma River's natural levee, while AED A is supposed to have a full-protection embankment surrounding all of it.

AED B covers about 19 per cent of the Project Area (some 1,000 ha).

AED C: Haparu Basin

AED C occupied the shallower south-eastern part of the natural depression which stretches from the north-western corner of the Project Area almost to its south-central limit near Chandpur. The extent of AED C had been increased by the construction of the Gangina cross-bund, which prevented natural flow into the deepest parts of the depression, in Zilkar Haor. The FAO soil mapping, however, seems to reflect this. AED C accounted for about 30 per cent of the depression, covering 12.5 per cent (some 650 ha) of the Project Area.

Soils were still classified by FAO as Noncalcareous Grey Floodplain Soils but in the low-lying lands they became finer-textured, with mainly silty clays or clays. They were also more acid, with topsoil pH 4.5 - 5.0 and subsoil pH below 6.0. Organic matter topsoil contents were higher with 2.0 - 4.0 per cent.

Only one crop could generally be grown: LV Boro using irrigation from the residual water. Very little kharif cultivation was possible; B. Aman was occasionally attempted around the fringes, not always successfully. Most of AED C became deeply flooded, consisting almost wholly of ML and L land, with no Highland and negligible settlement. Livestock grazing in the dry season and fishing were other important occupations.

AED D: Zilkar Basin

AED D occupied the rest of the depression, covering about 28 per cent (some 1,500 ha) of the Project Area. Although similar to AED C and a natural continuation of it, AED D included a higher proportion of Lowland compared to Medium Lowland than AED C. Both were mapped as Soil Association Se 480 by FAO, but whereas AED C probably had about equal proportions of ML and L, AED was up to 80 per cent Lowland.

AED D, therefore, in pre-project times suffered even deeper flooding than AED C, although the protection provided by the cross-bund helped prevent even higher flood levels. In addition to the fine-textured Noncalcareous Grey Floodplain Soils, more detailed soil survey would probably have revealed patches of Acid Basin Clays in the lowest parts of AED D. Acid Basin Clays are strongly acid (pH 4.0 - 5.0) throughout much of the upper soil, with organic matter topsoil contents upto 5.0 per cent.

Land use was much the same as in AED C, but with even more emphasis on irrigated Boro resulting from the additional supplies of irrigation water. Fishing and grazing also seem to have been more important than in AED C, due to a much greater extent of seasonal wetland and to deeper pools for fish.

AED D was the focus of much of the pre-project dispute between farmers and fishermen, over the use of residual pools. Fishing interests, in fact, were concentrated in the hands of a few local people of influence rather than the traditional fishermen whom they employed. They preferred to empty the pools as early in the dry season as possible, thus depriving the farmers of irrigation water. This conflict was a symptom of the social inequality widely reported by pre-project sources.

10.2 PROJECT OBJECTIVES

No account was taken of environmental aspects in the various project preparation documents (Section 10.3.6), 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 considered. Such issues include: external areas affected by the Project, both adjacent and downstream; fisheries; livestock; wetland ecology; river behaviour and ecology.

10.3 APPROACH AND SOURCES OF INFORMATION

10.3.1 Preliminary Environmental Post-evaluation (PEP)

Preliminary environmental post-evaluation (PEP) has been defined here as the post-evaluation equivalent of environmental appraisal (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. 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 10.3.5) for a specific crop year (Boro 1989/90 - Aman 1990). This permits comparison of with- and without-Project scenarios. The PEP, on the other hand, retains the before-and-after approach of the RRA studies, thus confining itself to the Project Area and any identified external areas (Section 10.3.3) affected by the Project. The PEP also evaluates the environmental impacts of the Project over all the years since project completion (and where necessary any impacts during construction that are of long-term significance).

This enables the PEP to take account of certain impacts which the PIE surveys will miss. In addition, the PEP covers the ecological (i.e. physical and biotic) impacts of the Project, as well as the human (largely socio-economic) impacts covered by the PIE surveys. The PEP takes advantage of the much more detailed level of the PIE findings with regard to human environmental issues. As the above comments show, however, the different temporal and spatial perspectives of the PEP and PIE surveys mean that their conclusions are not meant to be identical, but rather to complement each other.

10.3.2 Agroecological Divisions

The agroecological divisions used within the Project Area are the four AEDs defined in Section 10.1, with external (off-site) impact areas defined below in Section 10.3.3. The application of the AEDs requires clarification. Agroecological divisions are dynamic, changing especially in response to human influence. Thus AED C (Haparu Basin) has extended since the Project, due to drainage congestion in the north-west corner of Haparu Haor.

It is apparent from the discussion in Section 10.1 that AED B is not significantly affected by the Project and has incurred no costs as part of it. In the evaluation of the overall net project area impacts in Sections 10.4 - 10.6, therefore, no weighting is given to the zero impact values for AED B.

10.3.3 External Areas

The FAP 12 approach to environmental evaluation stresses the importance of taking into account not only environmental impacts within the Project Area, but also in areas outside it which are significantly affected by the Project. Project planning for Zilkar Haor and many similar projects in Bangladesh in the past has payed scant regard to such aspects. The FAP programme clearly must correct this.

There are three external areas affected by the Zilkar Haor Project:

- Surma Riverine Area (URA);
- Singar Riverine Area (IRA);
- Sadi Riverine Area (ARA).

The Surma is a large river, fairly incised in the landscape but still subject to overbank flooding in the wet season. As a result, there is a levee forming relatively high land, especially downstream of Mirzagaon road bridge. Below this, along the southern and western margins of Zilkar Haor, no embankment has been constructed and the levee serves this purpose. The

Surma Riverine Area, therefore, only extends along the south side of Haparu Haor. Spoil heaps from two cuts across river loops and various other low local bunds complicate water movements within the URA. Very high floods overtop the road embankment to enter the Project Area. The setback of the road from the river is generally 300-400 metres and is occupied by either cultivation or settlements.

Singar Riverine Area adjoins the Project Area along its northern boundary, with a full protection bund in the eastern half and a submersible bund for all except the last few hundred metres in the western half. North of the Singar there is no bund. There is only a very narrow strip of setback, usually less than 100m, between the Singar and the Project embankment. Very little is settled and cultivated and then only in the eastern stretch, so that project impacts in this riverine area trend to be minimal.

Sadi Khal is a small stream connecting the two larger rivers along the eastern margin of the Project Area. A relatively small embankment protects the Project Area in this higher land and there is only a narrow setback from the khal, although this is densely settled. To the east of Sadi Khal the Sylhet-Rajagaon road forms a more substantial embankment, containing no bridges or culverts.

The small size of the Zilkar Haor Project and the presence of few similar projects in the region, combined with the without-project magnitude of flooding caused by the excessive rainfall and flash-floods from the hills, make any downstream impacts of the Project negligible. No downstream external area, therefore, is considered necessary

The above discussion indicates that in general the impacts of the Project on external areas are likely to be less significant than in most other FAP 12 studies.

10.3.4 Control Area

The PIE socio-economic surveys include a Control Area (Bara Haor, east of Sylhet town) to provide a with- and without-Project comparison. For reasons discussed in Section 10.3.1, the Control Area has not been included in the environmental fieldwork, although the PIE findings are taken into account in the impact assessment for many of the human environmental issues in Section 10.6.

10.3.5 Identification and Assessment of Environmental Impacts

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

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

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

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

- ensuring that each primary impact is individually considered, while taking into account its often complex linkages with other primary impacts and with secondary or tertiary impacts;

- presenting a clear and very concise assessment, which is quickly and easily assimilated by the PEP user, enabling him to agree with or query it;

- avoiding voluminous and repetitious written presentations which soon become confusing, if not impossible, to read.

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

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

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

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

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

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

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

10.3.6 Sources of Information

Sources of information are given in the References at the end of this report. They include the socio-economic feasibility study (Chowdhury, 1983) and the Report of the Advisory Mission (EIP, 1983). There was also a baseline study (Ahmed, 1984) and BWDB's Project Proforma (BWDB, 1983).

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 information synthesised here has been collected, during the RRA and PIE field surveys.

FAO (1988), as noted, provided much of the ecological background.

10.4 PHYSICAL ENVIRONMENTAL IMPACTS

Physical issues have been subdivided into water-related and land-related (Table 10.2); other physical issues such as climate and atmosphere have not been affected by the Project.

10.4.1 Physical Impacts (Water)

a) River Flow

There are no active rivers within the Project Area. River flow, therefore, is considered only within the three external areas. The main parameters are discharge, velocity, timing, rate of rise, and duration. There are few FCD projects in the region, and none adjacent, so that cumulative impact is not significant. Similarly the small size of Zilkar Haor Project (5,300 ha.) means that its impact on flows in the Surma and Singar is negligible. Flow in the smaller Sadi Khal is slightly increased by containment by the embankment on what is its downslope side, although relative levels in the two main rivers are the major influence. The increased flow constitutes a minor negative impact on the riverine area environment.

b) River Quality

Potential key parameters are sewage, agrochemicals, sediment load and salinity. Again, the scale of the Project relative to the two larger rivers precludes any significant impact and even the Sadi Khal is unlikely to be affected, as it receives only small amounts of drainage effluent from the Project Area.

There has been some increase in the use of agrochemicals as HYV Boro has increased. Population growth would have occurred without the Project and in any case sanitation standards seem to be higher than average here, with latrines in most households. There is little sediment derived from the Project Area and salinity is not a factor in this high rainfall area.

c) River Morphology

The negligible influence on Surma and Singar flows means that the Project has not significantly affected river morphology parameters such as bank erosion, siltation and scouring. The Surma may be affected by the two river-straightening cuts but these are not related to the Project. Morphology in the small Sadi Khal is dictated by the two main rivers which it connects and by the fairly dense population along its banks.

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. A critical consideration in this respect was the high incidence of early flash-floods in April-May, resulting from proximity to hilly areas in India which claim the highest rainfall in the world (Cherrapunji has recorded average annual rainfall of over 12,000 mm and is only 40 km. north of the Project.)

Table 10.2 Physical Environmental Impacts.

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

Source: Consultants

AED A has benefited from substantial flood protection from all three adjoining rivers, with respect to both early and monsoon floods. However, both the road embankment in the south and the Sadi Khal bund are liable to overtopping by the highest river floods. In addition, structures along the road are poorly constructed, maintained and operated. At Jugirgaon an open bridge allows a small khal to connect with the second Surma cut, with no obvious control structure to prevent river inflow at high levels, except for a small bund across the khal channel. Excessive rainfall is still a source of some flooding, as in 1991, and little has been done to improve drainage efficiency along khals. In normal years, however, the high relative elevation seems to provide adequate natural drainage.

Despite the complaints of flooding within the embankment in southern Haparu Haor, therefore, it is evident that these are localised and that in general AED A has received a moderate positive impact. Early or high rainfall years, such as 1991, however still create adverse effects which preclude a major rating.

AED B, on the other hand, seems not to be significantly affected by the Project in any way, since it is not protected by any embankment from the Surma floods. These, however, affect it at only the highest river levels, as the natural levee acts effectively as a submersible embankment. Flooding incidence and patterns have not changed significantly since the Project, although some very slight improvement in drainage during early rains may occur due to the reduced flooding in AED D downslope.

AED C, the Haparu Basin, has received a variety of impacts on its flood regime. On the positive side, early flash floods have been prevented, a substantial achievement. The rate

at which the floods now rise in AED C is much slower, as they now result largely from rainfall run-off. Also, the gross amount of water entering the Basin has decreased considerably.

On the other hand, the high rainfall and surrounding elevated lands mean that the Basin continues to receive substantial rainfall run-off. The obvious inadequacy of the three-vent Gangina Khal Regulator means that this local floodwater leaves the area much more slowly than it used to. The result has been severe drainage congestion in AED C and its consequent expansion into the north-western corner of Haparu Haor.

The net environmental impact is assessed as in balance, with the reduction in the threat of early flooding countered by the more prolonged and extensive monsoon flooding. The latter, however, is claimed to have some inadvertent socio-economic benefits (Section 10.6).

AED D, the Zilkar Basin, is protected by the submersible embankment and clearly benefits from the exclusion of early river floods. The later monsoon floods, however, enter the area as before and result in deep inundation. There is some complaint of the inadequacy and poor operation of Dhumkhal Regulator, where unsatisfactory wooden dropboards are used. The physical impact is assessed as minor positive.

In assessing overall project impact, no weight is attached to AED B's zero rating , as noted in Section 10.3.2. The overall impact on flooding and drainage is assessed as moderate positive.

In all three external areas there is evidence of slight increase in flooding due to the embankment, but this is a fairly weak minor negative impact. This is especially so along the Singar where there is very little setback land to flood; there is unlikely to be any significant increase in flooding in the unprotected land north of the Singar, as flow levels are unlikely to be significantly raised.

e) Groundwater Levels/Recharge

Recharge to groundwater through the slowly permeable clay soils of the basins (AEDs C and D) is unlikely to be affected, since the extent and duration of standing water have not greatly changed. Extent has increased in AED C, while duration is less in AED D where early floods no longer occur, but neither is likely to be significant relative to the slow infiltration and percolation rates in the clay soils. Most intake of water is likely to be during initial flooding, when the clays are still cracked, and this will not have changed.

In AED A run-off is probably too rapid for significant percolation to have occurred pre-project, particularly with the impermeable ploughpans characteristic of rice soils. AED B has not changed, so no significant impact is recorded anywhere within the Project Area, nor in the riverine areas.

In addition to the above points, the Project Area is probably too small to influence significantly what are ultimately regional groundwater levels.

f) Groundwater Quality

Similar remarks apply as for river quality (see Section 10.4.1(b)). It is unlikely that the increased use of agrochemicals is sufficient yet to pose a threat to groundwater quality, especially with the slow percolation noted in (e) above.

g) Wetland and Waterbodies Extent/Recharge

The low spots in AED B are unaffected, as they are flooded as previously. In AED A the extent and recharge of the few low spots is decreased somewhat, but they still accumulate rainfall run-off and are in any case only a very small proportion of the AED, so no significant impact arises.

In AED C, as noted, the wetland may even have increased in extent, with the decrease in recharge more than compensated by the drainage congestion caused by the embankment, the silted Gangina Khal, and the inadequate Gangina Regulator. Thus a minor positive wetland impact is registered (although this has negative implications for the farmers concerned).

AED D has slightly reduced recharge, due to the loss of the early floods, but still receives the monsoon flood which is then more effectively contained than pre-project because of the embankment. Dhumkhal Regulator restores the balance and the net effect is no real change.

h) Wetlands and Waterbodies Quality

It is evident from the discussion in (b) and (g) above that the only AED that might suffer from deteriorating wetland water quality is AED C. Most of the increased agrochemicals use that does occur is in AED A, which drains into AED C. Other pollution caused by the dense population in AED A might also accumulate in AED C.

As in the other FAP 12 areas, the problem here is that no reliable data exist, either for the present or pre-project. At present, it is assumed to be unlikely that agrochemicals use has increased sufficiently to cause a significant impact, while sewage and other human pollution does not seem to be a problem in this area.

10.4.2 Physical Impacts (Land)

a) Soil Fertility

Natural soil fertility in Bangladesh seems to relate primarily to aquatic vegetation and the blue-green algae and other organisms that it nurtures. The vegetation supplies organic matter and organisms such as the algae provide nitrogen. Annual deposition of sediment by river floods is not considered an immediate source of soil fertility (FAO, 1988), despite the almost universal belief of Bangladeshi farmers that river silt is vital in this respect.

Assuming the above to be correct, it is the extent of inundation and resulting aquatic vegetation that is important. Since the extent of lengthily flooded land does not seem to have significantly changed, no impacts on natural soil fertility are assessed. The annual artificial increase in soil fertility by applied fertilisers is ignored, since it is largely consumed by crops or leached/washed away each year.

b) Soil Physical Characteristics

No significant impacts have occurred, for the reasons considered in (a) above.

c) Soil Moisture Status

Flood timing is again an important parameter in generally positive impacts on soil moisture status within the Project Area. The reduced flooding in AED A has meant a general improvement in soil moisture status, with improved drying-off without any danger of droughtiness, helped by the poorly permeable soils. In both AEDs C and D early over-wetting of the soils is now avoided and soil moisture can be maintained into the dry season much longer, with opportunities also for increased irrigation in many parts. Moderate positive impacts result. AED B is not affected.

The slight increase in riverine area flooding creates a minor negative impact due to more prolonged soil waterlogging in low parts.

d) Soil Erosion

The only soil erosion associated with the Project is that affecting the embankments. This is largely due to poor construction. Relatively limited use is made of the embankments because they are not suitable for any form of wheeled vehicles, not even bicycles or rickshaws, along most of their length. Only the cross-bund is motorable. Even grazing is discouraged by the widespread planting of Ipomoea, a plant said to be harmful to cattle and a skin irritant for humans. The plant however, may afford some protection against erosion.

A weak minor negative impact is assessed in AEDs A, C and D, where the embankments occur. The proportion of land involved in all three AEDs is small.

e) Land Capability

Clearly the improved flood regimes and soil moisture status have considerably raised land capability in much of the Project Area. This is particularly so in AEDs A and D where the critical improvement in flood timing now allows secure Boro cultivation where irrigation is available. Irrigation is widely available in AED D from residual water in low areas, while the Project's irrigation pipes supply parts of both AEDs A and D. AED A's land capability also benefits throughout from the reduced monsoon flooding.

In AED C benefits similar to those in AED D are countered by problems of drainage congestion caused by the Project, so that only a minor positive impact occurs. Again, AED B is not affected and the overall weighted impact for the Project Area as a whole is moderate positive.

In the external riverine areas a weak minor negative impact results from the slight increase in flooding.

f) Land Availability

The only significant change in land availability is the slight expansion of AED C, giving it more land available for fishing and rabi season cultivation. The extent involved does not represent a significant proportion of AED A.

There has been no permanent loss or gain of land in the external riverine areas due to the Project.

10.5 BIOLOGICAL ENVIRONMENTAL IMPACTS

Any attempt to assess the biological impacts of projects such as Zilkar Haor has to take account of parallel trends that were initiated long before such projects were conceived. These are essentially the 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, land settlement, vegetation clearance, hunting and fishing have all increased as population density 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 have already wreaked ecological havoc in most of Bangladesh.

Table 10.3 summarises the minimal biotic impacts in Zilkar Haor Project.

Table 10.3 : Biological Environmental Impacts

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

Source: Consultants

10.5.1 Biological Impacts (Fauna)

A basic problem in evaluating impacts of either population growth or the Project on all fauna considered in Section 10.5.1 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 exists, either now or for any previous time. The only broad numerical data available relate to fish catches in some areas of Bangladesh and these effectively show only what at that time fishermen wished or were able to catch. Thus all assessments in this section regarding past biotic baselines are based on inference and hearsay.

a) Bird Communities/Habitats

This issue provides a prime example of the point made above. Undoubtedly, in the distant past, the wetlands of Zilkar and Haparu Haors, even though relatively small, must have provided a haven for both local and migrant waterbirds. Only sporadic birdlife can be seen today, even in late November when the international waterbird migration is well under way.

Almost certainly, any difference between 1991 and 1983 is minimal and would largely have happened anyway, as population continued to grow. No significant impact can be ascribed to the Project, which has if any thing added to the actual extent of seasonal wetland. The wetland habitats had been completely disturbed pre-project by fishing, grazing and cultivation practices.

b) Fish Communities/Habitats

Fish communities and habitats have been subject to similar long-term trends, with human activities the dominant factor in fish ecology. In the absence of adequate data, the impression gained here, and elsewhere in Bangladesh, is that overfishing has in recent years led to a critical reproductive threshold being passed. It would seem that fish populations can no longer maintain themselves against the pressure of ever-multiplying numbers of fishermen using every conceivable method of catching every fish, whatever its size and stage of growth, that they can.

Zilkar Haor provides two illustrations of this ominous trend. First, long before the Project the practice in Zilkar Haor was to dry out every pool in the wetlands in turn, to extricate every fish, from both water and mud. New fry entered the area with the following year's monsoon floods (as they still do, with the submersible bund). Second, the banks of the Singar Khal in late November 1991 were lined with illegal sedentary fishermen using hook and line, some of whom reported catching nothing for two days. This gives a measure of the desperation now inherent in fishing in this area.

The submersible bund would have a negative impact if AED D were a successful habitat for flourishing fish communities, since the breeding adult fish would be unable to escape up-river in the early floods to spawn. However, in the circumstances that prevailed even before the Project it is difficult to ascribe any significant impact on fisheries.

To add to the downward trends caused by overfishing, over the last two to three years the Project Area, like much of Bangladesh, has suffered considerably from the ulcerative fish disease that is sweeping the country. This has been experienced in many other countries and seems from evidence elsewhere to be in no way related to factors such as increased agrochemicals use, which could be an indirect impact of the Project.

In AED C there is again conflicting information. On the positive side, it is held that the increased ponding of water caused by the Project encouraged local people to stock the area with fingerlings, to harvest after three years, and so obtaining a substantial catch and profit. Against this indirect impact, it is clear that a full protection embankment will admit few fish compared to river floods, or allow any to escape for spawning when necessary. However, AED C anyway seems never to have been as important for fishing as AED D.

The PIE surveys recorded declining fish production in both AEDs C and D, but this could easily be due to a continuing downward trend in capture fisheries caused by overfishing and the ravages of the fish disease. This seems likely to be the case in the Zilkar Basin (AED D). The greater influence of the full protection bund in Haparu Basin (AED C) suggests a weak minor negative impact.

Some interest in pond culture in AED A, in areas now relatively flood-free, offsets the effect of the embankment on the few low wet spots where limited fishing was possible pre-project. The net impact seems negligible.

Since AED C provided the habitats for a substantial proportion of pre-project fish populations, the slight negative impact there should be reflected for the Project Area as a whole.

The Project Area and its limited pre-project fishing activities are too small to affect significantly the river fisheries in the external areas. Again, the fish population is reported to be down, but probably due to overfishing and disease.

c) Other Macro-fauna Communities/Habitats

Most terrestrial fauna has long been reduced to negligible or low levels by population pressure. The only influence that the Project seems to have had, as elsewhere in FCD projects, is on the rodent population. The rat population is said to have increased, and the rats even to be larger than previously! Certainly, embankments provide an excellent habitat for rodents. Snakes also take advantage of disused rat-holes, but no increase in the snake population was reported.

Rats are causing increasing damage to Boro crops in AEDs A, C and D, where the embankments occur, and to crops and life in the Singar and Sadi riverine areas on the other side of the embankments. The problem is less marked along the road embankment. As a biological impact, however, the effect on the already depleted terrestrial or other fauna seems negligible.

d) Micro-fauna Communities/Habitats

This issue has already been touched upon in Section 10.4.2(a), where possible impacts on blue-green algae and other micro-organisms were examined in relation to soil fertility. As no data exist in Bangladesh on such matters, the inference drawn is the same as in Section 10.4.2 (a): no significant impact.

10.5.2 Biological Impacts (Flora)

a) Trees

The tree population in the area has not been significantly affected except possibly in AED A, where the scope to plant trees has increased. No attempt has been made to take advantage of the embankment for afforestation.

b) Other Terrestrial Vegetation

The widespread planting of Ipomoea, especially on the cross-bund, has been noted. It also seems to be propagating itself naturally on some stretches of embankment. On the other hand, sedges and grasses which flourish in the wetlands of AEDs C and D have diminished as the area of cultivated Boro increases there. Minor negative impacts are recorded for the two AEDs.

c) Aquatic Vegetation

Pre-project the communities and habitats were concentrated in the wetlands of AEDs C and D, with only small, scattered pockets in the low spots of AEDs A and B. On the basis of comments already made in Section 10.4.2(a), the virtually unchanged extents of seasonal wetlands cause no significant impacts.

10.6 HUMAN ENVIRONMENTAL IMPACTS

Some of the most important impacts of the Zilkar Haor Project are those affecting the human environment. This is inevitable in one of the most densely populated areas in the world, where the pre-project environment was already essentially an anthropic one.

Many of the human issues are covered in detail in other chapters of this report. Here they are presented in Table 10.4 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 the human impacts in terms of the different AEDs and external areas provides an additional distributional perspective to the more detailed discussions elsewhere in the report.

a) Crop Cultivation

Chapter 5 considers the overall impacts on crop cultivation, including irrigation, in detail. The positive impacts of the Project in this respect are clearer in Zilkar Haor Project than in most other FAP 12 studies. This is because :

- there has been no major increase in irrigation by tubewells or other means taking place prior to or since the Project;
- the Project started in 1986, by which time the HYV revolution in rice-cropping in Bangladesh was firmly established, but had failed to make any real progress in the Project Area because of the early and deep monsoon flooding.

In AED A there has been a strong moderate impact on crop cultivation. This has been due to very much greater crop security during both pre-monsoon and monsoon periods, giving increased Aus and Aman yields and initiating a swing to HYV varieties for both on the higher lands.

Table 10.4 Human Environmental Impacts

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

Source: Consultants

This trend has been accompanied by greater security and scope for irrigated Boro rice. The increase in HYV Boro has been particularly marked, but LV Boro has also expanded.

The Project has helped promote Boro not only by providing protection from early flooding but also by the provision of irrigation pipes, through which water lifted by LLP from the Singar is passed into AED A.

A major positive impact in AED A is precluded by the continued hazard from heavy rains coinciding with high river levels, especially in the pre-monsoon period. Coincidence is likely given the proximity of the hills, so that early heavy rain such as fell in 1991 can still destroy crops or reduce yields substantially. The PIE agricultural data (Chapter 5) relate to 1990, a very favourable year, in which the Project Area was protected but the Control Area was not. In 1991 the former suffered Boro and Aus damage almost on the scale of the Control Area.

Production in AED B cannot have been significantly affected by the Project because it is not really a part of it.

In AED C the main benefit is irrigated Boro rice protected from early flooding. However, only a minor positive impact is assessed because farmers there complain that both Boro and B. Aman crops are liable to failure due to drainage congestion, particularly in and around the north-western corner into which AED C has expanded.

In AED D there seems to be a substantial positive impact, due primarily to early flood protection allowing a considerable increase in Boro cropping, with both HYV and LV. Pre-project irrigation supplies through the Gangina cross-bund have been maintained by a series of irrigation pipes.

Overall, a moderate impact on crop cultivation is assessed for the Project Area as a whole.

The complaints of farmers in the riverine areas suggest that a weak minor negative impact is occurring there, but this is difficult to demonstrate. In the Singar area it can only be negligible, as so little cultivated land occurs.

b) Livestock

The increased Boro cultivation has inevitably reduced the area of pasture for livestock, although increased local rice production generally has increased supplies of straw and the capacity to purchase supplementary feed. The outcome in AEDs C and D seems to be a slight negative impact on animal numbers and health, but in AED D in particular pastoralism seems to be thriving far more than in most of the FAP 12 study areas. AED A is probably not significantly affected, as wetlands grazing areas were heavily concentrated in AEDs C and especially D. Chapter 6 discusses livestock in more detail.

c) Capture Fisheries

This issue has to a large extent been covered by the discussion in 10.5.1 (b) on fish communities and habitats. The same findings, albeit tentative, apply to capture fisheries, with the only significant impact attributable to the Project being a weak minor negative impact in AED C. Even this is probably open to dispute, given the background downward trends in capture fisheries caused by overfishing and, in recent years, disease. The uncertainties in assessing fisheries impacts are apparent from the detailed discussion in Chapter 5.

d) Culture Fisheries

Zilkar Haor Project has the lowest incidence of culture fisheries of any of the FAP 12 study areas (Chapter 5), although the opportunities in AED A especially are good. At present, no significant impacts arise, although some interest is reported in AED A.

e) Afforestation

Some increased tree-planting has been reported by the RRA in AED A but this is unlikely to be significant. The discussion in Section 10.5.2 (a) showed that so far there has been no impact on afforestation or tree-planting.

f) Agro-industrial Activities

The PIE survey (Chapter 7) reveals a considerable impact on associated agro-industrial activities, notably rice milling and marketing. This is concentrated within the Project Area in AED A and possibly in the adjoining Surma Riverine Area, where the easy access provided by the main road is a paramount factor.

g) Transport and Communications

Complaints about the interruption in boat communications are countered by recognition of the improved access, albeit by foot, provided by the Singar embankment and by vehicle access along the improved and now uncut the Gangina bund. Boat communications, in fact, must have already suffered pre-Project from the construction of Gangina bund. Nevertheless, it seems that boatmen along the Singar Khal have suffered a substantial limitation in their activities in this respect, while the Surma is unlikely to have been affected and may even have gained at the Singar's expense. Within the Project Area, there is likely to have been a net minor negative impact in the wetlands (AEDs C and D), but negligible in AED A (where the pre-existing main road dominates transport and communications).

h) Infrastructure

The Project has provided some protection to housing and commercial infrastructure. This is balanced by apparent greater damage in extreme flood years such as 1988, which may have resulted from an exaggerated sense of security having led to building in areas that seemed not to be at risk. Only AED A is affected, as it is the only part of the Project Area (other than the unprotected AED B) that contains significant housing and other infrastructure. A minor positive net impact is assessed.

A corresponding minor negative impact occurs in the densely settled Surma and Sadi Khal Riverine Areas. There is little settlement along the Singar adjoining the Project Area.

i) Domestic Water Supply

This seems unaffected. Groundwater levels and quality area are thought to have suffered no impacts, as noted in Sections 10.4.1 (e) and (f).

j) Sanitation

The possible problem here is the cessation of flushing-out by annual river floods in AED C. This still occurs to some extent in AED D, via the submersible embankment. As noted in Section 10.4.1 (h), no data are available to identify any negative impact. The general awareness of the problem and widespread use of latrines in the upslope areas of AEDs A and B, where settlement is concentrated, suggests that no significant impacts occur in AED C or D.

k) Recreation

No significant impacts.

l) Energy

The increased agro-industrial activity will be absorbing more energy, while decreased boat transport reduces energy use. However, only when energy is wasted or created by a project should negative or positive impacts be postulated.

10.6.2 Social Impacts

a) Human Carrying Capacity

The increased land capability and consequent increases in crop production have substantially raised the human carrying capacity, due basically to the greater flood control. Impacts reflect those in Sections 10.4.2 (c) and 10.6.1 (a), with similarly negative impacts in the riverine areas. Singar Riverine Area has suffered only very slightly from reduced crop production but has been the main impact area for boatmen.

b) Demography

Demographic structure and trends (Chapter 8) have perhaps been slightly affected in AED A, where the out-migration of young and middle-aged males to seek work elsewhere is likely to have declined. This is only a weak minor positive impact, at most.

c) Gender

A weak positive impact on the role of women by creating greater employment opportunities, particularly in paddy processing, is detected by the PIE (Chapter 9). This is concentrated in AED A, where most settlement occurs.

d) Age

No discernible impact arises, unless the increased agricultural activity offers more employment of the old or takes children out of school too early. Such impacts are unlikely to be significant and in any case balance each other.

e) Health and Nutrition

The increased food supply achieved by the Project must represent a benefit in this respect. The slight decline in food supply in the riverine areas is at least balanced by increases within the Project Area, where people own land on both sides of the embankment.

Shortages in food protein due to decline in fisheries or livestock may be occurring, in part due to the Project. No new health problems were reported as due to the Project, except one or two complaints about increased mosquitoes. In the absence of real data, it is assumed that net impacts are minor positive in AEDs A and D, where food production has increased most.

f) Disruption, Safely and Survival

The threat to safely and survival does not seem even to have been particularly great, compared to FAP/12 study areas nearer the larger rivers downstream. There must have been some seasonal disruption, however, in pre-project times, although the Gangina bund would have helped reduce this. AED C must benefit slightly, despite the current drainage congestion, while AED D benefits similarly in the pre-monsoon season. AED A is likely to receive a slight benefit also, from the reduced disruption due to flooding. In all three AEDs the embankments help by providing communications and temporary refuge.

The river areas suffer a corresponding negative impact, with increased flooding causing slightly greater disruption.

g) Land Ownership

There is some evidence (Chapter 8) that some people have been able to increase the size of their holdings but overall the Project's impact on changes in land ownership has not been significant. The area is still one of larger than average holdings. A slight negative impact does occur, however, where land has been lost to the new embankment, involving land owners on both sides of it, many of whom complain about the level of compensatory payments.

h) Equity

This was anticipated by the pre-project studies as a particular problem in Zilkar Haor Project, suggested by the number and size of relatively large holdings and the dominance of fisheries cooperatives by local influential persons. The Project, as is almost unavoidable in practice, has clearly benefited the larger landowners most, and the landless least, including boatmen and fishermen who in some areas have suffered negative impacts. The degree of negative impact is difficult to assess or quantify, but a general slight negative impact is recorded in both the Project Area and the riverine areas.

i) Social Cohesion

As noted, social cohesion (Chapter 8) was reported to be poor in pre-project times, although it is possible that this was overstated. Disputes between farmers and fishermen continue as do disputes between people inside and outside the road embankment. In AED A, a court case over sluice control is currently proceeding. Again, quantification is difficult.

A minor negative impact is assessed throughout the Project Area, except in the largely unaffected AED B. In the IRA and ARA, most residents own land inside the embankments.

j) Social Attitudes

Within the Project Area a good deal of overall approval for the Project was found. Specific deficiencies, notably drainage congestion, fisheries and livestock decline, and boat transport decline, were attributed to the Project but it was clear that people feel that they have benefited substantially. This is also indicated by the Project's freedom from public cutting of the embankments. A moderate positive impact is assessed for AEDs A and D where the most positive attitudes were encountered. In AED C, where the complaints about drainage congestion are loudest, the positive impact is only minor. An overall moderate positive impact in the Project Area is assessed.

In the Surma Riverine Area (URA), attitudes were on balance negative, although modified to a minor impact by the number of people with land also in AED A. In Sadi Khal (ARA), negative effects of the Project are minimal and a large number of people have part or all their land in AED A, so that a net positive impact results. In the IRA (Singar Khal) the net impact is balanced between boatmen who have suffered and the few farmers, who have most of their land in AED A. Overall, riverine area impact is also balanced.

10.6.3 Economic Impacts

The three main potential economic impacts on the people are on incomes, employment and land values. These have all received positive impacts from the Project, generally in proportion to the impacts on crop production (Section 10.6.1 (a)).

Negative economic impacts in the external areas are not generally significant, as they are largely balanced by benefits from land owned also within the embankments. Boatmen in the Singar Riverine Area have suffered loss of employment and income, but the small numbers involved make this only a minor negative impact.

Credit availability seems to have improved along with the other economic issues in the Project Area, as a result of the Project improving creditworthiness. There has been a minor positive impact on credit availability in the URA and ARA external areas, due to the ownership of land within the embankments.

Chapters 7 and 11 discuss the economic effects of the Project in detail.

10.6.4 Institutional Impacts

All FCD and FCD/I projects assume in their planning and design a high level of institutional activities and effectiveness, especially within the main institution concerned, the BWDB, but also the DAE. Sometimes the DOF is also included in the local institutional strengthening that is implicit in and planned by the Project. In defining institutional impacts by the Project, positive impacts are recognised where performance exceeds the planned levels and achievements and negative impacts where these fall short. Institutional impacts arise, therefore, due to the success or otherwise of project management.

On this basis, institutional activities and effectiveness in Zilkar Haor Project have suffered a slight negative impact. Operation and maintenance cause problems especially with

regards to the sluices along the main road. Operation of Dhumkal and Gangina Regulators appear to be satisfactory; it is the design, especially of the latter, that is inadequate.

Local participation in operation is not great and is mostly limited to influential people seeking their own ends. On the other hand, public consultation in preparing the Project seems to have been satisfactory.

10.6.5 Cultural Impacts

The Project has not affected scenic qualities or other aesthetic considerations. A minor negative impact on cultural sites arises in the Singar external area, where a graveyard and mosque located outside the bund by Gangina Regulator area are said to be temporarily unusable because of increased flooding. Cultural continuity seems unaffected.

Quality of life has clearly improved in the Project Area, due to the reduced flooding and improved economic conditions. A slight decline is likely in Singar external area, due to the boatmens' problems.

10.7 ENVIRONMENTAL SCREENING

Environmental screening uses the scoping exercise carried out in Sections 10.4-10.6 to evaluate project activities in terms of their influence on environmental impacts. The Project's primary activities were flood control and drainage, with an irrigation component to maintain and expand the previously existing systems. Scoping shows that the flood control and irrigation components have been achieved more or less as planned. They are responsible for most of the positive impacts of the Projects, often because of their combined effects. However, irrigation was widespread pre-project and it is flood control that has been the major environmental influence.

Drainage improvement has been less successful, especially with regard to drainage congestion around the inadequate Gangina Regulator. The limited excavation of Gangina Khal drainage system needs repeating and extending, once an additional or enlarged regulator is established. The drainage component, therefore, has been responsible mainly for either negative impacts or for the reduction of the positive impacts achieved by flood control and irrigation.

10.8 CONCLUSIONS AND RECOMMENDATIONS

Conclusions can be summarised in terms of the main environmental impacts of the Zilkar Haor FCD/I Project on the Project Area and the external riverine areas. Environmental impacts have been assessed by environmental scoping in Sections 10.4-10.6 and are presented in Tables 10.2 -10.4. The agroecological divisions (AED) are defined on Figure 10.1 and in Table 10.1.

a) The Project Area

AED B (Zilkar High Land), in the south west of the Project Area, has not been significantly affected by the Project, except to be consulted about it. No other impacts, therefore, have been identified there.

There have been no major positive impacts in the Project Area as a whole. The following moderate positive impacts are identified:

i. improved flood levels, timing and rate of rise, especially in AED A;

ii. a corresponding improvement in soil moisture status, in AEDs A, C and D;

iii. a rise in land capability, especially in AEDs A and D;

iv. increased and intensified crop cultivation (including irrigated crops) has occurred, especially in AEDs A and D, with much greater crop security;

v. as a result, agro-industrial activities have increased, mainly in AED A;

vi. human carrying capacity is higher, especially in AEDs A and D;

vii. social attitudes to the Project are positive, again especially in AEDs A and D;

viii. the economic impacts of the Project on the people (incomes, employment, land values and credit) have been substantial, particularly in AEDs A and D;

ix. the improved physical and economic conditions have meant a considerable improvement in the quality of life, with AEDs A and D the main beneficiary areas.

All of the Project Area has benefited except AED B, which accounts for 19 per cent of the total area. It is AED D (28 per cent) and especially AED A (40.5 per cent) which have gained most. In AED C (12.5 per cent) the chief reason for the lesser positive impact is increased drainage congestion caused by the embankment and the inadequate Gangina Regulator and Khal. Major positive impacts have not occurred because damaging floods can still occur in some years, as in 1991, due to heavy rainfall coinciding with high river levels which prevent drainage; this is exacerbated by the inadequate drainage structures. In addition, full flood protection is not provided by the submersible bund in Zilkar Haor itself.

No major or even moderate negative impacts appear to have occurred in the Project Area. Minor negative influences have been on soil erosion on embankments, fish communities/habitats, grass vegetation and a spread of Ipomoea, capture fisheries, livestock, boat communications, land ownership, social equity and cohesion, and institutional effectiveness.

It is noticeable from Table 10.3 that negative biotic impacts have been very limited. As in most of Bangladesh, ecological changes in the last few decades have been substantial in the Project Area. Such changes include the reduction in natural wetlands extent, accompanied by the marked decline in birds, fish and other wildlife. These had largely taken place in Zilkar Haor by 1983, when project construction started and would have continued subsequently irrespective of the Project. In the last three years, fish disease has added a further marked negative trend, again apparently unrelated to the Project.

It is difficult to asses, therefore, the degree of additional impact when the Project's influence is superimposed upon these ongoing trends and the already dominantly anthropic

landscape. Clearly, starting from such a biologically poor baseline as existed by 1983, biotic impacts are unlikely to be other than negligible or occasionally minor.

The substantial positive physical and human environmental impacts result in an overall moderate positive impact for the Project Area, when weighted by the extents of AEDs A and D (together covering 68.5 per cent of the area) and by the key issues involved.

b) External Impact Areas

Tables 10.2 - 10.4 also show the generally minor physical and human impacts of the Project on the external riverine areas along the Surma and Singar Rivers and the Sadi Khal. There have been negligible biotic impacts there. The Project is not considered to create significant cumulative downstream impacts because it is not part of any close group of similar FCD projects.

Most external impacts are negligible and some are minor, caused by the primary impact of slightly increased flooding against the embankments. Minor negative impacts also include: poorer soil moisture status; decrease in land capability; decline in crop productivity; increased damage to property and more disruption due to flooding; lower human carrying capacity; loss of land to the embankment; and less social equity. These are mostly fairly weak minor impacts, especially the human impacts, as these are usually balanced by benefits from land owned inside the embankment by the people living in the riverine areas.

The only moderate negative impact recorded relates to the marked decline opportunities for boat transport, especially along the Singar Khal.

The only significant positive impacts, both minor, are increases in agro-industrial activities, especially along the Surma, and better credit availability. Both are indirect and relate to project activities within the Project Area.

10.8.2 Recommendations

The Project seems to be generally successful and welcomed by the local people. Recommendations are therefore few but include the following.

i. Urgent attention should be given to supplementing or enlarging Gangina Regulator and the Gangina Khal drainage system, to relieve drainage congestion in the north west of Haparu Haor.

ii. Increased use of local labour for embankment and other maintenance would reduce erosion and promote employment and equity.

iii. Some effective method of monitoring fish communities is required, as elsewhere in Bangladesh; other biotic parameters are probably at too low a level for monitoring to be justified.

iv. Ways of upgrading livestock and grazing intensity to compensate for the reduced pastoral area should be examined.

v. The development of fish culture in ponds in the higher parts of AED should be encouraged.

vi. An investigation of the potential for tubewell irrigation should be conducted.

vii. A more socially acceptable method of operating the main road sluices should be found, presumably involving local committees rather than Union Chairman.

viii. The potential for embankment protection and production using trees, shrubs and/or grasses more suitable than Ipomoea should be explored.

ix. Given the generally beneficial physical and human environmental impacts of this small project and the very limited biotic impacts, there appears to be no justification for more detailed environmental evaluation (i.e. project environmental audit).

11 ECONOMIC ASPECTS

11.1 INTRODUCTION

The primary justification for the Zilkar Haor Project was based on its intended impact on agriculture. Three main sources of agricultural benefit were identified : increased irrigation, protection of rain-fed HYV from early flash floods, and protection of local Boro crops. The benefits flowing from the project however, are by no means limited to agriculture alone. Important areas of positive impact have been road transport, a more conducive social and organisational climate for economic growth, and psychologically a more secure environment, as the risk of severe flooding has receded.

Negative impacts have also been identified. These include some losses to fisheries, a reduced flow of income from livestock and a sharp impact on boat navigation.

An attempt has been made in this chapter to quantify the benefits and costs of the project, primarily based on the effects on crop agriculture. Other impacts are treated in a more qualitative manner.

11.2 PROJECT COSTS

The financial and economic costs of the project are shown in Table 11.1 below. The data in the table were obtained from the Project Proforma and from BWDB, Sylhet. Conversion factors for economic pricing are from FPCO (1991), and the breakdown into cost components for application of the conversion factors was based on MPO (1987). The inflation indices used to derive the 1991 financial prices were the agricultural wage rate index (for labour or labour-intensive works, such as earthworks) and the construction cost index (for building materials and structures).

Table 11.1 Financial and Economic Costs
(Tk. lakhs; 1991 prices)

Year	Financial		Economic	
	Capital	O&M	Capital	O&M
1983/4	60.0		35.4	
1984/5	118.0		69.7	
1985/6	271.6		160.4	
1986/7	120.6		71.2	
1987/8	74.1		43.8	
1988/9	29.7	31.8	17.5	22.6
1989/90	59.7	12.4	42.5	8.8
1990/91	115.8	15.0	11.2	

Source: BWDB and Consultants

The relatively large O&M expenditure in 1988/89 was due to project rehabilitation costs needed after the unusual 1987 and 1988 floods, and is not expected to recur during the remaining life of the Project. Annual O&M costs in future are assumed to be the mean of the 1989/90 and 1990/91 costs.

11.3 INCREMENTAL OUTPUT AND NET RETURNS

There is very little that is cultivated in the Zilkar Haor area apart from paddy, (see Chapter 4) so that this exercise is focused exclusively on paddy.

Table 11.2 Project Impact on Paddy Output
(1991 prices)

	With Project	Without Project
Average yield (mt./ha.)	2.08	1.04
Gross output (mt.)	9969	4985
Gross Incremental (mt.)	4985	
Financial Value of Gross Incremental Output (Tk.,m.)	26.8 /1	
Economic Value of Gross Incremental Output (Tk.,m.)		

Source: PIE Survey.
Notes: /1 Includes value of byproducts.
Paddy (harvest) price assumed at Tk.5091/mt.
By-product prices derived from FPCO (1991), adjusted by the GDP deflator (crops) to convert to 1991 prices.

Table 11.2 reflects the very significant difference in crop yields and output between the Project and control areas. The financial value of gross incremental output was found to be Tk.26.8 million, and the economic value to be Tk. 26 million.

The average costs of production (of all paddy crops) for the Project and control areas are shown in Table 11.3 in both financial and economic terms.

Table 11.3 Financial and Economic Costs
(Tk./ha., 1991 prices)

	With	Without
Financial (Tk./ha)	10509	8869
Economic (Tk./ha)	8933	7010
Total Economic Cost (Tk.m)	42.8	33.6
Change in Eco Cost (Tk,m)		

Source and Note: PIE Survey.
Economic Values were obtained by using conversion factors supplied by FPCO (1991).

Table 11.3 records the average economic and financial costs of paddy production. The net increase in cultivation costs is valued at Tk.9.2 million, which when deducted from the value of gross incremental output gives us the net benefit arising from the project. This is estimated at Tk. 16.8 million/year.

11.4 NEGATIVE IMPACTS

Three areas of negative impacts were identified. These included livestock, fisheries and navigation. A quantitative estimate of the impact on the livestock sector is available and this is reported in Table 11.4 below.

Table 11.4 Impact on Livestock

	With	Without	Changes	
			Number	Tk.(m)
Cattle	7806	9499	-1693	-5.60
Buffalo	484	518	-34	-0.19
Goats & Sheep	552	829	-277	-0.14
Chickens & Ducks	21380	21380	-	-
Total Loss (Tk., m.)				-5.93

Source: PIE Survey.

The net capital loss in financial terms, arising from the project, is estimated at Tk.5.93 m. The economic equivalent of this amount at an SCF of 0.82 is Tk.4.86m. This, however, is a once for all change. An alternative way of looking at the problem would be to see the effect on the flow of livestock related incomes.

Net incomes from livestock sources accruing to households are shown in Table 11.5.

Table 11.5 Net Income from Livestock Sources
(Tk. in 1991 prices)

	Gross Income/HH	Costs/HH	Net Income	
			Per HH	All HH (Tk,m)
With	2270	1034	1236	4.27
Without	1990	853	1337	4.62
Change			- 101	- 0.35

Source: PIE Survey

An annual loss of Tk. 0.35 m as arising from the reduction in livestock related sources of income, appears to be associated with the Project. Its economic value is Tk.0.29m. Thus, although the impact of the Project on the livestock sector is negative, its magnitude is small (see Chapter 5).

The estimated capture fishery loss arising from the Project has been estimated at between Tk. 2.8 to 3.4 million (at 1991 economic prices) - see Chapter 6.

It has not been possible to quantify the Project impact on navigation. Thus the impact on fisheries has been small, while the impact on navigation, has probably been somewhat greater.

11.5 BENEFIT COST ANALYSIS

The benefit cost analysis of Zilkar Haor Project, has taken into account the impact on crop agriculture and fish losses. Other impacts have been ignored.

Table 11.6 Benefit-Cost Estimates

	PP	PIE	RRA
EIRR	25.8	40	-
BCR @12%	4.87	3.4	-
NPV (Tk., m.) @12%	-	134.6	-
Gross paddy output (mt.)	4054	4985	5470

Source: PP, PIE, RRA

The above table summarises the results of the analysis, where the EIRR generated by the PIE data is found to be significantly higher than the initial (pre-project) estimate. Details of the economic cash flow are shown in Tables 11.7 and 11.8. The PIE data suggest that yields in the control area were sub-normal so that on the basis of a simple comparison with the impacted area, Project impact may seem exaggerated.

It should be noted however, that part of the objective of the Project is precisely to reduce flood related damage of the type reported from the control area, so that ideally, a weighted average of normal and sub-normal yields should be taken to measure impact. Although this has not been possible, the PIE generated information that made it possible to arrive at an approximation of normal control area yields. The net impact of the Project still remains high, generating an EIRR of around 16 per cent (Table 11.8). Maximum and minimum EIRRs were also estimated on the basis of maximum and minimum (average) yield differences derived from standard errors for the Project and Control areas. The maximum and minimum EIRRs were estimated at 61 and 17 per cent.

11.6 CONCLUSION

Small projects with a clear and simple concept like the Zilkar Haor Project, appear to yield a high rate of economic return, and deserve encouragement. Some negative impacts, particularly on navigation, could perhaps be minimised by suitably altering the engineering design of structures, for example by providing navigation locks on khals crossing the Project area. This would require comprehensive baseline studies before project planning, to ascertain the volume of boat traffic and the economic costs and benefits of mitigatory measures. A similar approach is also clearly necessary for avoidance or mitigation of adverse fishery impacts.

Table 11.7 Economic Cash Flows for Zilkar Haor Project (PIE Data)
(Constant economic values, 1991 prices, 00,000 Taka)

Year	Fish Losses	Agricultural Benefits	Capital Costs	O&M Costs	Total Costs	Net Economic Benefits
1983-84			35.4		35.4	-35.4
1984-85			69.7		69.7	-69.7
1985-86	-3.4	84	160.4		160.4	-79.8
1986-87	-3.4	126	71.2		71.2	51.4
1987-88	-3.4	126	43.8		43.8	78.8
1988-89	-3.4	168	17.5	22.6	40.1	124.5
1989-90	-3.4	168	42.5	8.8	51.3	113.3
1990-91	-3.4	168	15	11.2	26.2	138.4
1991-92	-3.4	168		10	10	154.6
1992-93	-3.4	168		10	10	154.6
1993-94	-3.4	168		10	10	154.6
1994-95	-3.4	168		10	10	154.6
1995-96	-3.4	168		10	10	154.6
1996-97	-3.4	168		10	10	154.6
1997-98	-3.4	168		10	10	154.6
1998-99	-3.4	168		10	10	154.6
1999-2000	-3.4	168		10	10	154.6
2000-01	-3.4	168		10	10	154.6
2001-02	-3.4	168		10	10	154.6
2002-03	-3.4	168		10	10	154.6
2003-04	-3.4	168		10	10	154.6
2004-05	-3.4	168		10	10	154.6
2005-06	-3.4	168		10	10	154.6
2006-07	-3.4	168		10	10	154.6
2007-08	-3.4	168		10	10	154.6
2008-09	-3.4	168		10	10	154.6
2009-10	-3.4	168		10	10	154.6
2010-11	-3.4	168		10	10	154.6
2011-12	-3.4	168		10	10	154.6
2012-13	-3.4	168		10	10	154.6
2013-14	-3.4	168		10	10	154.6
2014-15	-3.4	168		10	10	154.6
2015-16	-3.4	168		10	10	154.6
2016-17	-3.4	168		10	10	154.6
2017-18	-3.4	168		10	10	154.6

Table 11.8 Economic Cash Flows for Zilkar Haor Project (PIE data)
(Constant economic values, 1991 prices, 00,000 Taka)

Year	Fish Losses	Agricultural Benefits	Capital Costs	O&M Costs	Total Costs	Net Economic Benefits
1983-84			35.4		35.4	-35.4
1984-85			69.7		69.7	-69.7
1985-86	-3.4	38.2	160.4		160.4	-125.6
1986-87	-3.4	58.7	71.2		71.2	-15.9
1987-88	-3.4	58.7	43.8		43.8	11.5
1988-89	-3.4	79.2	17.5	22.6	40.1	35.7
1989-90	-3.4	79.2	42.5	8.8	51.3	24.5
1990-91	-3.4	79.2	15	11.2	26.2	49.6
1991-92	-3.4	79.2		10	10	65.8
1992-93	-3.4	79.2		10	10	65.8
1993-94	-3.4	79.2		10	10	65.8
1994-95	-3.4	79.2		10	10	65.8
1995-96	-3.4	79.2		10	10	65.8
1996-97	-3.4	79.2		10	10	65.8
1997-98	-3.4	79.2		10	10	65.8
1998-99	-3.4	79.2		10	10	65.8
1999-2000	-3.4	79.2		10	10	65.8
2000-01	-3.4	79.2		10	10	65.8
2001-02	-3.4	79.2		10	10	65.8
2002-03	-3.4	79.2		10	10	65.8
2003-04	-3.4	79.2		10	10	65.8
2004-05	-3.4	79.2		10	10	65.8
2005-06	-3.4	79.2		10	10	65.8
2006-07	-3.4	79.2		10	10	65.8
2007-08	-3.4	79.2		10	10	65.8
2008-09	-3.4	79.2		10	10	65.8
2009-10	-3.4	79.2		10	10	65.8
2010-11	-3.4	79.2		10	10	65.8
2011-12	-3.4	79.2		10	10	65.8
2012-13	-3.4	79.2		10	10	65.8
2013-14	-3.4	79.2		10	10	65.8
2014-15	-3.4	79.2		10	10	65.8
2015-16	-3.4	79.2		10	10	65.8
2016-17	-3.4	79.2		10	10	65.8
2017-18	-3.4	79.2		10	10	65.8
			EIRR			15.70

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