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 KOLABASHUKHALI PROJECT

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Hunting Technical Services Limited

in association with

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

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

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

Kolabashukhali Project

Project Summary Sheet

Project Name	: Barnal-Salimpur-Kolabashukhali Project
Project Type	: Flood Control and Drainage
Location	
FAP Region	: South-West
District	: Khulna and Jessore
Area (ha.)	: 25 500 ha. (gross) 18 623 ha. (cultivable)
Funding Agency	: IDA
Implementing Agency	: BWDB
Construction started	: FY 1979/80
Scheduled Completion	: FY 1983/84
Actual Completion	: FY 1983/84
Original Cost Estimate	: Tk.
Final Cost Estimate	: Tk. 224.25 million (1991 prices)
Major Flood Damage:	:
Repair/rehabilitation in	:

Overview:

A large but technically simple FCD project aimed at excluding both daily saline tidal inundation and seasonal river flooding. The Project has resulted in major reductions in depth of inundation and has reclaimed several thousand hectares of previously uncultivable land. There has been some movement into HYV T Aman, but the main agricultural benefits are from increased area and greater security of the existing cropping pattern based on B Aman and Local T Aman. There is little irrigation, and the Project has had negligible impact on Boro paddy. There have been considerable capture fishery losses, but EIRR is estimated to be 24 per cent including such losses, the good performance being in large part due to the completion of the Project on time and to cost. Drainage congestion remains a problem, and rehabilitation and replanning of the drainage structures is required.

KOLABASHUKHALI PROJECT

SUMMARY OF FINDINGS

Location

The Kolabashukhali Project, more accurately known as the Barnal-Silimpur-Kolabashukhali Project, is located on the borders of Jessore and Khulna Districts in south-west Bangladesh, and is within the FAP South-West Region.

The Project area is a tidal river island, approximately 25 500 ha. in gross area, surrounded by the Atai River in the west, the Nabaganga to the north and north-west, the Chitra to the east, the Atharabanki to the south-east and the Bhairab to the south (see Figure 1.2)

All the nearby areas with a similar agro-ecology are within, or being incorporated in, polders. The Bhuter Beel Project, immediately east of Kolabashukhali, is not yet completed, so the unprotected north-central portion of the Project was used as the control area for the PIE survey (see Figure 1.3).

Project Objectives

The rivers around the Project area have a tidal range of up to 2.44 m. and, in the absence of flood control infrastructure, the low lying parts of the area were inundated twice daily. In the low water season saline water advanced northwards, rendering irrigation using river water hazardous except at the northern extremity of the Project area. Prior to the Project much of the low-lying area was occupied by extensive beels, a large area was uncultivated and much of the rest could only grow a single B Aman or Aus/Aman LV crop.

The Project had three main objectives: protection against high river stages and exceptional floods by construction of a ring flood embankment around the island; control of seasonal and daily flooding by closing the outfalls from khals into the main rivers with regulators that would permit drainage at low tide and low river stages; and facilitation of irrigation, again by means of the regulators in those areas where water salinity levels permitted irrigation. In addition the Project was intended to improve the internal drainage network and to upgrade internal communications through construction of an internal road network.

Project History

The Project was the subject of a feasibility study by the BWDB Special Projects Division in 1977 and was adopted for funding with assistance from the World Bank under IDA credit 864-BD. It was built between 1979 and 1984. The Project was the subject of an evaluation study in 1986 and information from that evaluation was used by FAO in preparation of a Project Completion Report (1989) and by the World Bank in their Project Performance Audit Report (1990), but it was noted that the evaluation was conducted too soon after Project completion, and contained methodological flaws which seriously limited its value.

Construction and Design

The main engineering features of the Project are an 85.5 km. ring flood embankment, 16 drainage and/or flushing sluices, 8.9 km. of drainage channel improvement, 18.9 km. of access roads and 9 culverts on these roads. The Project appears to have been well conceived and implemented, although the provision of drainage facilities appears to have been inadequate.

However, most of the structures are now in poor condition, the network of drainage channels has almost disappeared and some of the access roads are severely damaged.

Hydrological Impact

The Project has generally achieved its intended hydrological impact. It has succeeded in protecting the area from high tides and monsoon floods, in reducing soil salinity by preventing saline intrusion, in increasing security against tidal river level fluctuations and in facilitating irrigation from the rivers in the northern part of the Project area.

The area of previously very low land (24 per cent of Project area) has been converted to effectively 'higher' land with reduced monsoon season water levels; land at MPO levels F4 and F3 has been converted to F2, and F2 has been converted to F1 and F0. A similar but much smaller change was found in the control area, but the latter is itself a partly completed Project. Hence, KBK has functioned effectively as a land reclamation project and reductions in monsoon season flooding have permitted a substantial increase in the cropped area during the kharif season, estimated at between 2000 ha. and 5000 ha. Flood durations have also been reduced somewhat, though there is still a substantial area under water for 5 or more months.

Because much of the Project is a series of basins, monsoon season drainage is limited. Coupled with the inadequacy of the drainage system this results in acute drainage congestion at the height of the monsoon season, and at other times of heavy rainfall.

There is relatively little irrigation in the Project area (only 6 per cent of land operated by sample households) but this is more than in the control area. Since the Project there appears to have been a small expansion of STW irrigation in both areas, but this is probably only part of the national trend, and the largest area of irrigation is managed by a traditional surface water system based on a tidal khal and predating the Project.

Operation and Maintenance

Standards of maintenance at Kolabashukhali are poor, and have resulted in serious degradation in the Project infrastructure. About 30 per cent of the embankment length needs repair and resectioning, two of the sluices were inoperable and three quarters were leaking profusely at the time of the RRA, and the drainage channels had not been desilted. Problems with the sluices are partly due to poor construction and site investigations.

Khalashis are employed for all the sluices and appear to be active in operating them. There are sluice committees at almost every sluice, but they do not function effectively in conflict resolution, they do not reflect the interests of all those who are affected by sluice operation, and there have been disputes over their operation, particularly due to the conflicting interests of influential shrimp farmers and Boro paddy growers in part of the Project.

Agricultural Impact

The Project has had a substantial agricultural impact. It has permitted the reclamation of between 2000 and 5000 ha. of land for cultivation of Aus and Aman paddy. There has been a shift in the cropping pattern due to reduced flooding,from B Aman and jute to mixed Aus/Aman around the beels and from uncultivated peat wetlands to B Aman within much of the beel centres. Cultivation of the peat soils, however, is not as successful as on the alluvium, and may face problems in the longer term. In the higher lands in the north and south there have been changes from B Aman to TL Aman, and less markedly, from TL Aman to HYV T Aman. Sugar cane has expanded in these areas and along the narrow strips of settled land in the beels. The extent and importance of jute have diminished. The Project was successful in 1987 and 1988 in protecting monsoon paddy crops, which suffered less damage than the same types of paddy in the control area.

The cropping intensity seems not to have changed on the lands that were already cultivated, although reduced kharif season flood depths and duration appear to have led to a move from rabi crops to more profitable Boro paddy, where irrigation is feasible.

Surface water irrigation development has been very limited because of the saline tidal water still penetrates upstream seasonally in the adjacent rivers, which prevents irrigation in the latter part of the rabi season except in the north around Kalia. Groundwater irrigation potential is likewise limited to a small area in the north, since the southern part of the Project lies near the boundary of coastal saline groundwater intrusion. However, there has been some interest in LLPs in the Project area, and retention of surface water inside the Project might promote further expansion of irrigation.

The net result of these changes is an estimated annual incremental output of about 19 000 mt. of paddy over the without project estimate, offset by a relatively small decrease in output of rabi crops and of Local Boro, which is adversely affected by the drier with-Project conditions. In general, land prices have increased more in the Project area than in the control, reflecting these benefits.

Livestock Impact

The Project appears to have had no impact on the bovine population in the Project area. Cattle populations in the area are generally inadequate to meet Aman season draught power requirements and although there are increasing numbers of power tillers in the area there is likely to be a draught power constraint on kharif season cropping. The Project area has a significantly higher ovine population than the control area, but total numbers of sheep and goats are relatively small. Within the Project area livestock owners have to spend substantially more on purchased feed than in the control area, and as a result net household incomes from livestock are some Tk 700 a year lower.

Fisheries Impact

The Project has had a severe impact on capture fisheries, but has benefitted culture fisheries of both shrimp and carp. The number of full-time fishermen has fallen, and reduced opportunities for capture fisheries within the Project area because of beel drainage have led to increased intensity of river fishing. Blockage of migration routes between rivers and beels has probably reduced river yields, a process exacerbated by the increased fishing pressure.

The farming of fresh-water shrimps has been facilitated by embankment protection and the tidal water control possibilities offered by the sluices, although there is often a conflict of interest over sluice operation between the shrimp farmers and rice cultivators. There is evidence of more new development of cultured fishponds for carp in the protected area than in the control area, presumably because of reduced flood risk.

Overall the capture fisheries and river fisheries losses are estimated at between 322 and 456 mt. a year, and are as yet only slightly offset by an increase in output of about 39 mt of (albeit more valuable) cultured species.

Infrastructure and Communications

The embankment and the access road constructed under the Project have permitted an improvement in communications within the Project, bringing consequent social and economic benefits. The area still suffers, however, from lack of vehicle access in the southern half, and of a vehicle ferry to Khulna. The land transport benefits are also offset to some extent by a substantial decline in boat transport and the number of boatmen.

More than three-quarters of the enterprises engaged in non-farm activities within the Project area stated that they have benefited from the Project. Businessmen reported that the 1988 floods caused more damage inside the Project than in the control area, but this is not confirmed by household flood losses; the former sample is small, and entrepreneurs may have miscalculated drainage risks.

Socio-Economic Impact

There appear to be no differences in occupational pattern between Project and control areas, although in the Project area a small number of non-agricultural labourers have moved into agriculture. Similarly, a comparison between the Project and control areas suggested that slightly more non-farm economic activity, particularly in rice milling and trading and input marketing, was evident in the Project area.

Kolabashukhali does not show the usual pattern of declining workload for women in rice husking, because there is little irrigation by STW and thus STW engines are not available to power the mills. Although the city of Khulna is not far away, poor communications prevent use of urban rice mills by the Project population. On the other hand, workload in other agricultural activities has increased in the Project area, in most cases due to higher output, while in the control area a few cases of actual decline were noted, due to problems of waterlogging and pest attack.

Incomes in the Project area appear to be slightly higher, but notably both landholding and landless households appear to be better off in the Project area, suggesting a less inequitable impact on incomes than in other projects studied by FAP 12. However, this would obscure two important distributional impacts with the effect of a higher contribution from salaries (perhaps due to relative proximity to Khulna and two Upazila towns). Capture fishermen, as usual, have suffered disproportionately from the reduction of flood depth and duration and reclamation of low areas for agriculture, except in the (unusual) case of those who had a right to land that was occupied by beels and who now cultivate that land. Some dissatisfaction and even intra-village violence over the implications of the Project were reported, despite there having been local committees during implementation.

Landholding changes have affected more households in the Project than in the control area, partly reflecting land acquisition which had affected 20 per cent of Project area households. Reportedly 21 per cent of acquisitions were not compensated, while in 39 per cent of cases compensation was only obtained after payment of a bribe. However, more households have increased their holding, and this may reflect the conversion of beels into agricultural land (although this was probably not detected in full by the survey). Despite the existence of National legislation governing the distribution of reclaimed khas lands, and knowledge of the relevant provisions by Upazila officials, few or no landless households appear to have benefited from the increase in cultivable area.

Respondents confirmed many of the observed impacts, reporting that the main benefits were from flood protection, agriculture and improved communications, and the main disbenefits from waterlogging, loss of fisheries, and declining soil fertility. The benefits are reflected in households building extra rooms for their houses in the Project area, and also more houses in the Project area are of earth walled construction, suggesting reduced flood risk. Since 1987, more households in the control area have suffered flood damage, and the value of damages have also been slightly higher than in the Project area.

Environmental Evaluation

The major changes in the flooding regime have led to significant ecological changes, as several thousand hectares of land which were perennially flooded are now largely under cultivation. These included large areas of peat soils, which were previously covered with reed beds providing rich habitats for waterbirds, fish and other aquatic biota. These are now largely destroyed. There is some danger that the peat soils will shrink and acidify as cultivation proceeds. The positive impacts on the human environment from the Project are substantial, although many capture fishermen are worse off as a result.

Economic Appraisal

As the agricultural analyses resulted in a range of estimated benefits and disbenefits, the economic analysis examined a range of possible outcomes. However even the least optimistic analysis, based on benefits derived from cropping pattern and yield changes only, without the reclamation effect, gives an EIRR of 24.4 per cent. With the lowest estimate of reclaimed area the EIRR is 25.5 per cent. It is therefore clear that the Project has been a substantial success.

Recommendations

Following several years of inadequate maintenance a substantial rehabilitation of the Project infrastructure is required. This should be accompanied by a redesign of the drainage infrastructure. Consideration should be given to installing the previously planned system of motorable roads, accompanied by a vehicle ferry to Khulna.

Systems of impounding water in the beel areas should be investigated, to preserve wetlands for fishery development and to retain water for irrigation. The development of fishponds should be facilitated, especially for groups of displaced fishermen.

Special advice is needed for farmers on the cultivation of peat soils.

The potential for groundwater development deserves more detailed attention. Given the large amount of land now available for dry-season irrigation, attention to the quality and cost aspects of tubewell development might be amply rewarded.

Detailed monitoring of river salinities could also allow more irrigation than was thought possible in the past, since farmers' long-established knowledge of river salinity may have been superseded by the containment effects of recent years. Certainly the fears expressed in the Feasibility Study, based on a salinity limit of 500 μmhos/cm for paddy irrigation, were unnecessarily alarmist, since this is the limit for perfect irrigation water, while usable water can be up to 2250 μmhos/cm..

The potential for embankment protection and production using trees, shrubs and/or forage grasses should be explored.

A project environmental audit is recommended, to provide more environmental data and analysis, especially of the ecological and long-term physical environmental impacts.

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ABBREVIATIONS AND GLOSSARY

AED	Agro-ecological Division
AER	Agro-ecological Region (FAO)
AES	Agro-ecological Subregion
Aman	Main monsoon paddy crop
Aus	Early monsoon paddy crop
BIDS	Bangladesh Institute of Development Studies
Boro	Winter season paddy crop
BRDB	Bangladesh Rural Development Board
BSS	Bittahin Samabaya Samiti (Landless Cooperative Society)
BWDB	Bangladesh Water Development Board
crore	ten million (10,000,000)
DOF	Department of Fisheries
DRA	Dhonagoda-Gumti Riverine Area
DTW	Deep Tubewell (with displacement-type pump)
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
FAP	Flood Action Plan
FCD/I	Flood Control and Drainage with or without Irrigation
FCDI	Flood Control Drainage and Irrigation
FPCO	Flood Plan Coordination Organisation
ghat	landing place
ha	Hectare (2.47 acre)
HYV	High Yielding Variety (esp. of paddy)
IEE	Initial Environmental Examination
JICA	Japan International Cooperation Agency
khal	Natural channel/minor river/tidal creek
kharif	monsoon agricultural season
KSS	Krishak Samabaya Samiti (Farmers' Cooperative Society)
lakh	one hundred thousand (100,000)
LLP	Low Lift Pump (for irrigation from surface water body)
m-d	Man-day
MBSS	Mahila Bittahin Samabaya Samiti (Landless Women's Cooperative Society)
md	Maund (unit of weight = 37.3 kg.)
MDIP	Meghna-Dhonagoda Irrigation Project
MPO	Master Plan Organisation (of Ministry of Irrigation, Water Development & Flood Control) (now National Water Plan Organisation)
MSS	Mahila Samabaya Samiti (Women's Cooperative Society)
mt.	metric tonne (1,000 kg., 2,204 lb.)
NGO	Non-governmental Organisation
NPV	Net Present Value
O&M	Operation and Maintenance
ODA	United Kingdom Overseas Development Administration
PCC	Project Coordination Committee
PCR	Project Completion Report
PEP	Preliminary Environmental Post-evaluation
pH	Positive Hydrogen Ion Concentration
PIE	Project Impact Evaluation
PP	Project Proforma

RRA	Rapid Rural Appraisal
SAR	Staff Appraisal Report
SCF	Specific Conversion Factor (from financial to economic prices)
Union	Administrative level below Upazila (q.v.), typically 10 per Upazila
Upazila	Administrative unit above Union & below Zila (460 Upazilas in Bangladesh)
rabi	winter agricultural season

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

1 INTRODUCTION

1.1 THE FAP 12 STUDY

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

The objective of FAP 12 is to conduct post-evaluations of a total of 17 projects, representative in type and location, of the FCD/I projects so far executed in Bangladesh (see Figure 1.1). The results of these evaluations will be passed to other FAP components, the Government of Bangladesh, and the donor agencies supporting FAP, 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 Kolabashukhali-Barnal-Salimpur Project, more conveniently known as the Kolabashukhali Project (KBK).

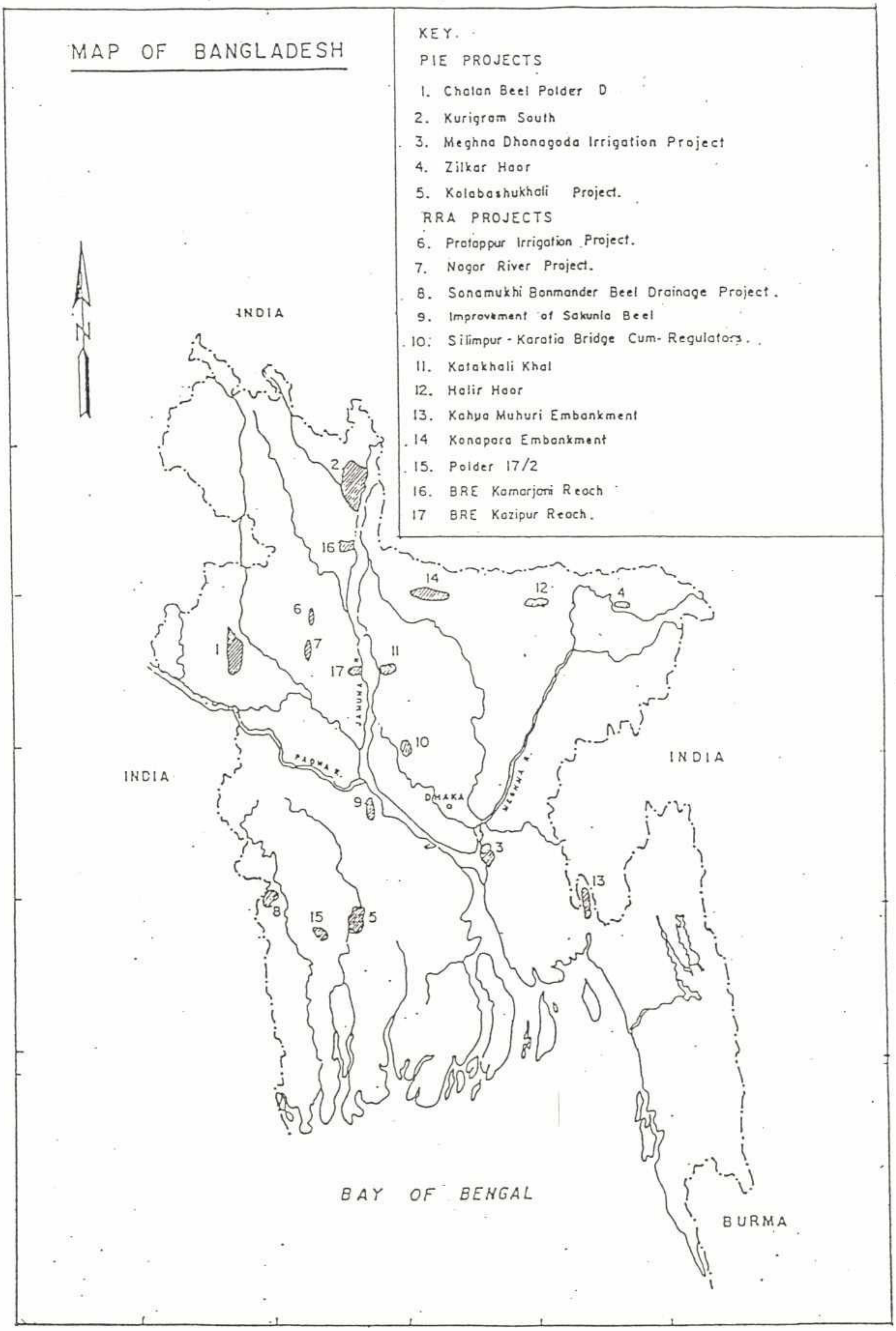
1.2 PROJECT DESCRIPTION

1.2.1 Location and Topography

Kolabashukhali Project is located in south-western of Bangladesh (Figure 1.1), on the boundary of Jessore and Narail Districts. Parts of the Project area fall in Terokhada, Rupsa and Daulatpur Upazilas of Khulna District and in Kalia Upazila of Narail District, but does not include the whole of any of them. The Project lies within the Flood Action Plan's South-West Region and in BWDB's Khulna Operation and Maintenance (O&M) Circle.

The Project area consists of an island, approximately 25,500 ha. in gross area, surrounded by tidal rivers. These comprise the Atai to the west, the Nabaganga to the north and north-west, the Chitra to the east, the Atharabanki to the south-east and the Bhairab to the south (see Figure 1.2). The Upazila towns of Terokhada and Kalia lie within the Project, and the large city of Khulna lies immediately across the Bhairab to the south, some of its suburbs falling within the Project area. Communication with Khulna from most of the Project area is however poor, due to the scanty road network and to the lack of a vehicle ferry across the Bhairab.

Figure 1.1 Location of Selected PIE and RRA Projects



Source: Consultants

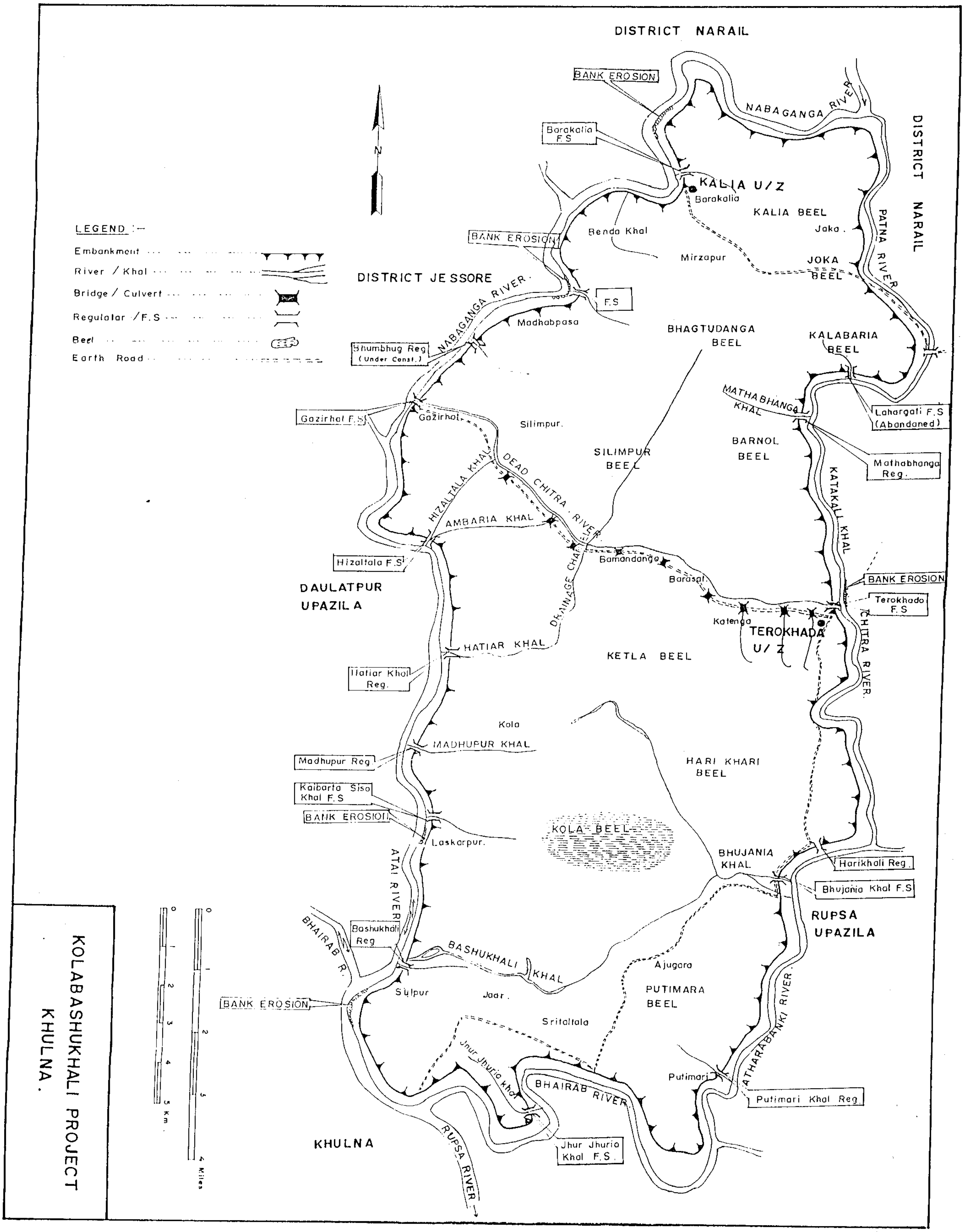


Figure 1.2 Kolabashukhali Project - Impacted Area

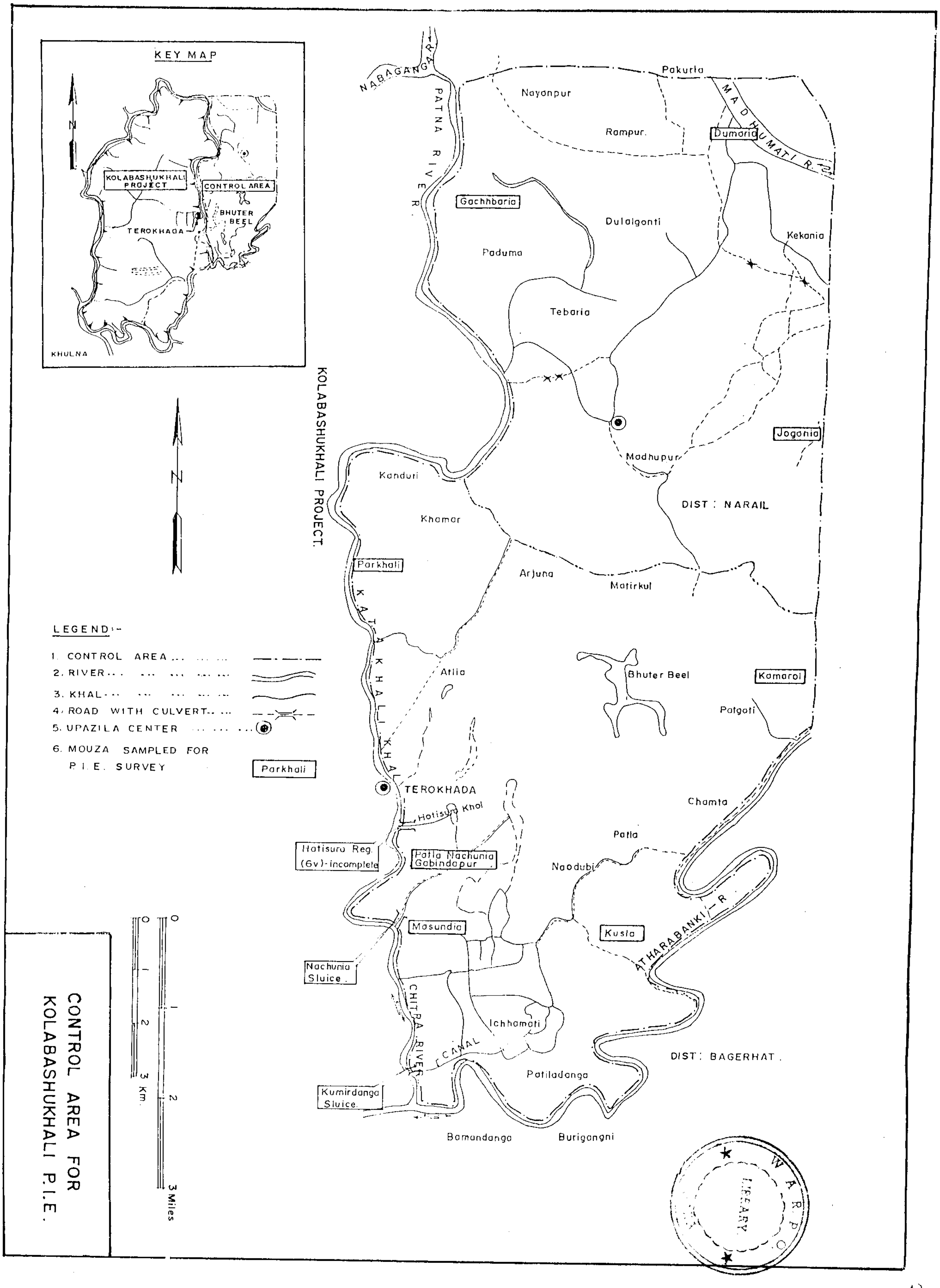


Figure 1.3 Kolabashukhali Project - PIE Control Area

The rivers have a tidal range of up to 2.44 m. (8 ft), sufficient in the absence of flood controls to inundate the low-lying parts of the area daily. In the low water season from February to May saline water advances northwards, making irrigation with river water impossible except at the northern extremity.

The island has a rim of relatively high ground (over 2.5 m. above PWD datum) around the edge and along the levees of numerous khals which penetrate the interior. Most of the interior, however, consists of low lying land, much of which was occupied by beels in the pre-project period and was flooded both daily and seasonally by water penetrating through the khals. As a result, before the Project a large area was uncultivated, and much of the rest could grow only a single crop of deep water Aman.

1.3.2 Project Interventions and History

The Kolabashukhali Project was built between 1979 and 1984 with funding from the World Bank under IDA credit 864-BD. This credit also covered the adjacent Chenchuri Beel Project, and the Brahmaputra Right Embankment rehabilitation; two sections of the latter are subjects of FAP 12 RRA reports. The Project aimed to control both daily and seasonal flooding by closing the outfalls of the khals into the main rivers with regulators which could be opened at low tide and low river stages to permit drainage of excess water. Some of the regulators were also intended to admit water for irrigation, in continuance of existing local practice. To provide protection against high river stages and exceptional floods, a ring flood protection embankment was also constructed round the entire periphery of the Project.

The objective of the project interventions was to make available for cultivation land which had previously been too deeply flooded, and by providing shallower and more stable water levels to encourage the move from low yielding B. Aman and Aus/Aman to higher yielding transplanted Aman. Although facilities were provided for 2-way operation of the sluices, irrigation was not a major objective, due to the limitations posed by river water salinity in the dry season.

1.3 METHODOLOGY

1.3.1 Previous Evaluations

In selecting projects for PIE study, FAP 12 deliberately excluded those for which a previous evaluation of good quality had been made, thereby avoiding unnecessary duplication of effort. KBK was the subject of an evaluation study by Engineering Science Ltd. of Dhaka (ESL 1986) shortly after completion, and some of the data from that study were used by the FAO Investment Centre for the Project Completion Report compiled on behalf of the World Bank in 1989 (FAO 1989). However, the ESL evaluation was considered by FAO to have been conducted too soon after Project completion to offer a reliable guide to impact. FAP 12 concurs with this view, but would point out that responsibility for the timing lies not with ESL, but with BWDB which commissioned the study.

Unfortunately, the ESL study has serious methodological drawbacks in addition to its problems of timing. The survey used a two-stage sample design, similar in principle to that employed by FAP 12 (see 1.3.2 below), but which did not conform to the requirements for probability sampling. While the total number of respondents was sufficient for reasonable levels of statistical precision and confidence in the survey results, the first-stage sample units (villages) were selected purposively, so that no statistical generalisation from the results is possible. A second problem is that the sample households are concentrated in a small number of villages (3 in each of the protected and nearby unprotected areas), so that even considered as a set of case studies, they do not cover a wide enough range of conditions to permit safe qualitative generalisation about Project impacts.

1.3.2 RRA and PIE Surveys

FAP 12's methodology for project evaluation has been described in detail in the FAP 12 Methodology Report (FAP12 1991a) and the experience with its application in practice has been reviewed in the FAP 12 Final Report (FAP12 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.

In addition to the main data sets collected from the households in the second stage of the sample, data on some aspects of project impact and community response were measured by a community survey consisting of group interviews conducted at the first level of sampling, the mouzas. The community survey is thus also a probability sample, although the sample size is too small for a high level of statistical precision to be expected.

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 Final Report.

1.3.4 The FAP 12 Surveys of Kolabashukhali

Kolabashukhali was selected for intensive study in consultation with the Flood Plan Coordination Organisation of the Ministry of Irrigation, Water Development and Flood Control. Preferably the FAP 4, the South-West Regional Study, would also have been involved in project selection, but this was not possible since FAP 4 mobilised some time after FAP 12. KBK was selected as representative of the important class of tidal/saline exclusion polders in the South-West Region.

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

The PIE of KBK was conducted in August 1991, following the methodology described in Section 1.3.2 above. Selection of a control area for KBK proved difficult. For comparability, the control area had to be subject to the same tidal range, height of river flood and seasonal penetration by saline water. These conditions implied an undisturbed area the same distance inland on the same river system as KBK. All the land to the west of the Atai and Nabaganga is protected by the Chenchuri Beel and Barakpur-Diganalia Projects, while the land east of the Chitra is in the process of being embanked under the Bhuter Beel Project. However, the embankment and structures of Bhuter Beel were not complete in 1991, so although there was some danger that this area had already been affected by the incomplete works, it was selected for comparison with the Project area (see Figure 1.3). Bhuter Beel occupies another river island, which stretches further north than that containing Kolabashukhali; to maintain comparability of hydrological conditions, all the part of Bhuter Beel north of the northern end of KBK was excluded from the control area.

The difficulty of selecting a control for KBK exemplifies the problems of using the control area approach for FCD evaluation in parts of Bangladesh where there are high concentrations of existing projects. These problems will increase as FCD works are extended, and the days of the control methodology are probably numbered in much of the country.

In the impacted area a total of 120 cultivating and 48 labour households were sampled in 24 clusters, falling in 19 different mouzas, while 60 cultivating and 24 labour households, in 9 different mouzas, were sampled in the control area. The locations of the sampled mouzas are shown in Figures 1.2 and 1.3.

1.4 ACKNOWLEDGEMENTS

FAP 12's staff spent extended periods in the KBK 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 Khulna O&M Circle, for their assistance in providing accommodation and boats to FAP 12 staff working in the area. Thanks are also due to the then Chairmen of Terokhada and Kalia Upazilas, and to the Upazila Nirbahi Officers and other officials of the Upazilas, for their assistance during fieldwork. FAP 12 is grateful to the Chairmen and Secretaries of the Union Parishads containing the sample mouzas, for access to local tax registers for sampling purposes. Last, but by no means least, FAP 12 wishes to thank the over 300 rural dwellers, both men and women, who gave their time and shared their experience with the study teams.

2 ENGINEERING ASPECTS

2.1 PHYSICAL AND HYDROLOGICAL SETTING

2.1.1 Locational and Physical Characteristics

As described in Chapter 1, the KBK project area is a river island with an area of about 25,500 ha, surrounded by a network of tidal channels. The island has a rim of relatively high ground (over 2.5 m. above PWD datum) formed by the levees of the main rivers around the edge, and there is also high ground along the levees of the numerous khals which penetrate the interior. Most of the interior consists of low lying land, much of which was occupied by beels in the pre-Project period, and which is divided into fairly distinct sub-catchments.

The surrounding rivers have a tidal range of up to 2.44 m. (8 ft.), sufficient in the absence of flood controls to inundate the low-lying parts of the area daily. In addition, during the monsoon the higher river stages prevented rainfall in the Project area from draining, causing acute drainage congestion in the Project area.

The island on which KBK is situated is elongated along a north-south axis, and in the low water season from February to May saline water advances from the seaward (southern) end, making irrigation with river water dangerous except towards the northern extremity (from Gazirhat northwards, see Figure 1.2). Low area were inundated daily with saline water during the dry season, and it is likely that soil salinity persisted to some extent during the early monsoon.

The effect of the pre-project hydrological regime was that land below 2 feet (0.6 m.) PWD was uncultivable due to excess water, while cultivation between 2 and 4 feet (0.6 - 1.2 m) PWD was risky (Feasibility Report, BWDB 1977). The uncultivable areas were estimated to comprise about 20 per cent of the gross area, while the risky areas comprised a further 43 per cent. The risky areas were given a degree of protection by small earthworks and flap gates, constructed on local initiative. At the same time, scope for dry-season cultivation was restricted by the salinity of the river water at the period of greatest demand and by scarcity of groundwater.

2.1.2 Flood Characteristics of the Project Area

The KBK area combines Flood Types T (Tidal Flooding) and L (Local rainwater congestion) as defined in FAP 12's flood typology (see FAP 12 Final Report, Appendix G). In addition, there was an element of Flood Type M (main river monsoon flood) though the main flows in the Ganges/Brahmaputra system largely bypass the Khulna area. Daily tidal variations are much larger than the seasonal variations, but the low-water period of river flow (December-March) gives tidal maxima some 0.8 - 1.0 m. lower than in the monsoon.

2.2 PROJECT OBJECTIVES

The main objectives of the Project, as stated in the Project Proforma (PP) (BWDB, undated) were flood control and drainage. The Project was designed to protect the entire Project area from daily tidal inundation and from the peak monsoon floods in the surrounding rivers, and to eliminate drainage congestion. A secondary objective was to facilitate irrigation, but the Feasibility Report notes that the scope for this was limited by the salinity problem. The Project was also intended to improve the internal road communications of the area. The stated objective of these measures was to increase crop yields, improve the cropping pattern, and improve the condition of the farmers.

The PP does not specify its objectives in any detail, but the targets for flood control can be extracted from the Feasibility Report (BWDB 1977). The specific hydrological targets for the different land levels in the Project are shown in Table 2.1; this is based on the Feasibility Report, with F levels estimated by FAP 12 on the basis of the stated land levels and flood depths.

As shown in Table 2.1, the specific hydrological objectives of the Project in flood control and drainage were:

- to reduce the duration of inundation sufficiently for B Aman to be grown in the previously uncultivable zone between 0.5 and 2 ft PWD;
- to reduce flood depth and duration sufficiently to make B Aman secure in the previously risky lower part of the 2 - 4 ft PWD zone, and to make cultivation of a rabi crop possible throughout the zone; and
- to reduce flood depth in the 4 - 6 ft PWD zone sufficiently for Local T Aman to replace B Aman and Aus/Aman, with a following rabi crop on all land.

It was further hoped to facilitate the conversion of all land between 6 and 8 feet PWD from B Aus/Aman to Local T Aman, but it was recognised that the drying-out of the Project implied by the improvements at lower levels would expose the T Aman to moisture stress, and this move was therefore conditional on development of supplementary irrigation.

The hydrological objectives of KBK, and their relationship to the cropping pattern, seem to have been clearly and realistically considered. It is interesting to note that, in the lower areas (below 4 ft PWD) the main emphasis was on reducing duration, rather than depth, of flooding; the main reason for the lowest lands being uncultivable not so much the depth of water, as the absence of any dry period long enough for land preparation.

2.3 PROJECT STRUCTURES

The Project design adopted to achieve the hydrological objectives was the closure of the khals with sluice gates, in order to exclude both daily tidal flooding and the peak monsoon river floods, and the construction of a ring embankment to prevent the natural levees being overtopped by peak water levels in the stretches between the sluices. To facilitate daily discharge of rainwater at low tide, most of the sluices were of flap-gate type, and it was planned to deepen and link the interior khals to provide a drainage network discharging through the sluices. Some of the sluices were designed to act as flushing (irrigation) sluices to admit water which could be applied to the fields either by gravity flow (at high tide) or by low-lift pumps. A transverse road link, with drainage culverts, was planned to improve communications between the west side of the Project area at Gazirhat and the east side at Terokhada (see Figure 1.2).

Table 2.1 Hydrological Objectives of Kolabashukhali Project

Land Level (PWD datum)	Area (ha.)	Pre-Project Status				Expected Post-Project Status			
		Depth of Flooding (m.)	Duration of Flooding	F-level	Cropping	Depth of Flooding (m.)	Duration of Flooding (months)	F-level	Cropping
< 0.5 ft (0.15 m)	810	2.1	12	F4	Uncultivable		12	F4	Uncultivable (aquaculture?)
0.5 - 2 ft (0.15 - 0.6 m)	3765	2.1 1.65	12	F4	Uncultivable	1.98	8 - 10	F3	B Aman
2 - 4 ft (0.6 - 1.2 m)	9798	1.65 1.05	11	F3	Risky B Aman (57%) Safe B Aman (43%)	0.9 1.52	6 - 7	F3	Safe B Aman + Rabi
4 - 6 ft (1.2 - 1.8 m)	3562	1.05 0.45	5 - 7	F2	B Aman or Aus/Aman + some Rabi	0.3 0.9	3 - 5	F2	Local T Aman + Rabi on whole area
6 - 8 ft (1.8 - 2.4 m)	1903	0.45 0.2	2 - 4	F2/ F1	Aus/Aman or Local T Aman, + Rabi	0 0.3	0 - 2	F1	Local T Aman (with irrig.) + Rabi
> 8 ft (2.4 m)	2834	0	0	F0	Houses, roads	0	0	F0	Houses, roads

Source: BWDB 1977

The earthworks and structures built were very substantially in accordance with the original concept. The present condition of these works is described below, and the condition of the awter control structures is summarised in Table 2.1.

2.3.1 Embankment

The total length of the embankment is 53.13 miles (85.50 km.). The embankment was constructed according to the design criteria, but the general condition of the embankment has deteriorated at several reaches due to lack of regular maintenance works. The embankment slopes are damaged due to raincut and wave action at many places, and the embankment needs immediate attention at these points. Other problems are noted below.

a) Ghogs

The structures of the embankment from milage 22-24 and 30-34 have problems of ghogs (tunnelling) each year, mainly due to crab and rat holes. According to the BWDB Khulna office, seven stretches of the embankment totalling 15 km. face this problem to varying degrees. About 30 per cent of the embankment needs repairs and re-sectioning.

b) Public Cuts

In 1988 there were six public cuts at different locations on the embankment to get rid of internal drainage congestion. Three of these were between mileages 44 and 47, on the south-west side of the Project, reflecting the natural tendency of excess water to accumulate in the large Kola Beel depression (see Figure 1.2). Public cuts are not a regular occurence in KBK, despite numerous complaints about the incidence of drainage congestion caused by inadequate drainage structures. Reluctance to resort to cuts does not, however, necessarily indicate that complaints about drainage are ill-founded. It may stem rather from appreciation that in the prevailing tidal conditions relief would be short-lived, and cuts could be very difficult to repair in the face of large daily flows.

c) Erosion and Embankment Retirement

Erosion at the following locations has created threats to the embankment, and to adjacent land and property:

i. River Bhairab at Showalpur and Laskarpur (threat to embankment);

ii. River Nabaganga at Madhabpasa and Kalia (land and property);

iii. River Chitra at Terokhada (threat to Upazila Health Centre and Upazila Office Complex).

A retired embankment at milage 7-8 was constructed in 1989 after the erosion of the original embankment.

Table 2.2 Kolabashukhali Project - Summary of Condition of Water Control Structures

Type and Location of Structure	Present condition of structure									Present Condition of Drainage Channel	
	Regulator/Sluice							Gate		Need reexcavation (km)	
	No. of Vents	Gate Type	Wing wall C/S	Wing wall R/S	Box	Apron C/S	Apron R/S	Gate	Rubber Seal/ Groove	C/S	R/S
Madhabpasa F.S. (used for flushing & drainage), (M:2-3)	1	F.G.	G	G	G	P	L.T. to be provided	G	P	G	P
Kalia Khal F.S. (used for flushing & drainage), (M:6-7)	1	F.G.	G	G	G	P	L.T. to be provided	-	P	G	F
Lohargati Khal F.S.(Abandoned), (M:17-18)	1	F.G.	G	G	Filled up with soil	Buried in Soil		Not visible (Buried)	Buried	1.0 km	0.5 km
Mathabhanga Regulator, Flushing cum Drainage. (M:18-19), Incomplete (New)	2	V.L.	G	G	G	G	G	G	G	2.0 km	0.5 km
Terokhada F.S. (M:21-22)	1	F.G.	G	G	G	G	G	P(C/S)	P	1.0 km	0.15 km
Harikhali Reg., (M:28-29) Regulator operation was stopped for about 3 years	2	V.L. (C/S) F.G. (R/S)	P	P	Settled 20 cm P	P(L.T.)	P(L.T.)	1 Gate damaged	P	4.5 km	0.5 km
Bhujniar Khal F.S. (used for flushing & drainage, (M:2930)	1	F.G.	G	G	P	P(L.T.)	P(L.T.)	G	P	1.6 km	0.5 km
Putimari Khal Reg., (M:32-33)	3	F.G.	P	P	G	P(L.T.)	P(L.T.)	G	P	2.0 km	0.5 km
Jhurjhuria Khal F.S. (used for flushing & drainage), (M:37-38)	1	F.G.	G	G	G	P(L.T.)	P(L.T.)	G	P	3.0 km	0.5 km
Bashukhali Khal Reg., (M:42-43)	6	V.L.	G	G	G	P(L.T.)	P(L.T.)	Lifting parts missing	P	3.0 km	0.5 km
Kaibarta Sisa Khal F.S., (M:45-46)	1	F.G.	G	G	G	P(L.T.)	P(L.T.)	G	-	-	-
Madhupur Khal Regulator (box silted and out of operation, M:46-67)	2	V.L.	P	P	6" Settled & out of operation	G	G	Not working	G	4.0 km	0.6 km
Hatiar Khal Regulator, (M:48-49)	8	V.L.	G	G	G	G	G	1 is out of operation	G	1.5 km	0.5 km
Hizaltala Khal F.S., (M:50-51)	1	F.G.	G	G	G	P(L.T.)	P(L.T.)	G	P	G	G
Gazirhat (Gangusia Khal) F.S., (M:52-53)	1	F.G.	G	G	G	P(L.T.)	P(L.T.)	P leaking under sized	G	1.5 km	0.4 km
Bhumbhug Khal Regulator, (M:0-1)	Under construction (Construction stopped due to foundation failure)										

Note: C/S - Country Side; R/S - River Side; V.L. - Vertical Lift; F.G. - Flap Gate; G - Good; F.S. Flushing (irrigation) Sluice; P - Poor; L.T. Loose Tellus; M - Embankment mileage

(32)

2.3.2 Regulators

The total number of water control structures (regulators and sluices) constructed under the Project is 16 (Table 2.1), which are categorised as follows:

i.	Drainage Regulator	=	6
ii.	Flushing Sluice	=	9
iii.	Drainage-cum-Flushing	=	1.

All the regulators/sluices are constructed in accordance with the design criteria.

All the existing sluices, which were constructed for single function operation (either drainage or flushing) are being used for both drainage and flushing purposes, causing damage to the loose aprons and the guide bunds on both river and country sides. The present condition of the structures is shown in Table 2.1.

The Madhabpur Khal drainage sluice has settled by about 7"-8" and at present out of operation.

The Harikhali Khal drainage sluice has also settled by about 6" but has been brought back into operation after minor repair.

The Mathabhanga regulator is still under construction and the work on Bhumbhug regulator (under construction) has been stopped because of problems with foundations.

About 75 per cent of the sluice gates are leaking profusely due to deterioration of the seals, causing water intrusion into the Project area.

The Lohargati Flushing sluice (1 vent) is almost buried in the soil and abandoned.

There is a strong demand from the local people for construction of several new regulators to relieve drainage congestion (see 2.3.1(b) above).

2.3.3 Channels

The network of drainage channels has almost disappeared in most locations and has not been extended into the lowest parts of the beels. The total length of the excavated or improved drainage channels is about 8.85 km. The Benda Khal, near Kalia in the north of the Project, is used as an irrigation canal, but does not have a Project-constructed sluice and is not under Project management.

Almost all the outfall channels on the river side of the regulators are silted up to a great extent.

2.3.4 Access Roads and Culverts

The access road between Gazirhat and Terokhada (constructed by BWDB) is about 18.9 km. long with 7 culverts. It is severely damaged at several places, particularly between Barasat school and the Katenga Khal culvert. The approaches to the culverts on this road are badly damaged. There is no culvert on an existing channel near Bamandanga village and on

Hatiar Khal. Foot traffic presently passes using bamboo bridges, but the road does not fulfil its objective of permitting wheeled transport between the two sides of the Project.

2.4 IRRIGATION ASPECTS

2.4.1 Surface Water Irrigation

All the flushing and drainage sluices are being used for flushing to admit irrigation water from the rivers to the existing khals and to the beel depressions. There are actual and potential conflicts between cultivators and shrimp farmers over operation of the sluices, which have in the past led to sluices being opened at inappropriate times, with consequent crop damage by saline water.

The Benda Khal, near Kalia at the northern end of the Project, has no regulator but is managed by local residents who close it with a cross-dam in the monsoon. It is used to admit water from the Nabaganga River during the Rabi and early Kharif seasons for irrigation of HYV Boro, water being supplied to the land both by Low-Lift Pumps (LLP) and by gravity at high tide. Irrigation was observed to be still in progress during the RRA visit in April. Irrigation with river water further south is risky after February, due to increasing salinity levels in the rivers, though there is a small area of minor irrigation supporting HYV Boro production on the north-east side of the Kola Beel, drawing water from the Bhuzniar Khal with LLPs. These minor irrigation developments could provide a model for increasing agricultural output in KBK by expanding the irrigated HYV Boro area.

2.4.2 Tubewell Irrigation

About 5-6 Shallow Tubewells (STW) are installed in and around Chhota Kalia village, at the northern end of the Project, adjacent to the Nabaganga River and the locally developed Benda Khal irrigation system. The STW are used mainly for irrigation of HYV Boro. Tubewells are scarce in other parts of the Project area, local informants stating that wells were liable to cease yielding and/or to produce gas. The Project area is in any case classified as having saline groundwater at depth, and thus being unsuitable for widespread tubewell irrigation.

2.5 PROJECT IMPLEMENTATION

The Kolabashukhali Project was first started in 1961-69 by local Government, but could not be carried out due to insufficient preparation, changes in scope of work, and inadequate funding. Later on, funding of the Project was taken up by IDA in 1978-79 and construction on an appropriate scale was initiated. The Project was declared complete during the year 1982-83, though the IDA PCR (FAO 1989) shows expenditures continuing into FY 1984/85. KBK has the distinction amongst large FCD projects (especially compared to the neighbouring Chenchuri Beel Project funded under the same IDA credit) of having been completed within the planned time and cost.

2.6 ASSESSMENT OF PLANNING, DESIGN AND IMPLEMENTATION PERFORMANCE

2.6.1 Positive Findings

The Project has fulfilled its primary engineering aims by:

- controlling the high tides and monsoon floods;
- reduction of salinity through preventing salt water intrusion;
- increasing security against water level fluctuation;
- creating some scope for irrigation by LLP.

The detailed hydrological impact of the Project is described in Chapter 3. The Project also allows more reliable year-round road communication within the polder.

2.6.2 Negative Findings

a) Faults in Project Concept

A major limitation on agricultural output from the Project is the shortage of water supply in the Rabi and early Kharif seasons, which prevents cultivation of HYV Boro except in a few areas where river water is fresh enough to be safely used. The Feasibility Report and the Project as implemented did not seriously address this limitation, although there are areas in the Project which cannot be drained and which may have potential for combined use for water storage for irrigation and for fishery development.

b) Drainage Problems

Parts of the Project area still face acute drainage congestion during the height of the monsoon season, and during heavy rainfall at other times, due to:

- inadequate number and capacity of the existing drainage facilities, leading to imperfect water control in the low lying areas particularly during the rainy season;
- failure to develop a fully interconnected system of drainage channels;
- failure to maintain the drainage channels and structures;
- construction of new link roads between villages without providing drainage culverts.

Although the Project has significantly improved agricultural conditions in the protected area, these problems have caused it to fall short of its planned hydrological and agricultural objectives (see Chapter 5).

2.7 RECOMMENDATIONS

2.7.1 Modification and Rehabilitation of Kolabashukhali Project

i. The entire drainage canal network of KBK should be re-excavated and extended, including the outfall (riverside) canals.

ii. A hydrological reassessment of the KBK drainage network should be made, to determine its capacity and the flows it is required to handle. If present complaints of inadequate drainage are substantiated, new drainage facilities should be constructed. A provisional identification of suitable sites is as follows:

Bhuzniar Khal	-	drainage/flushing sluice
Benda Khal	-	" " "
Kola Khal	-	" " "
Dead Chitra River (E. end)	-	" " "

The Dead Chitra should be re-excavated and its western end connected to the new Bombhag Khal regulator or to an existing regulator.

iii. Early attention should be given to repair and maintenance of damaged and leaking sluices. In particular the Lohargati sluice, at present abandoned and inoperable, should be rehabilitated. The settled regulators at Madhupur and Hari Khali Khals should be modified to bring them to proper operating condition.

iv. Sluices originally designed for one-way operation (drainage only or flushing only) should be modified to permit safe two-way operation, since this type of operation is already taking place at all sites.

v. The scope for and benefits to irrigation in KBK, using impounded water and/or minor irrigation techniques, should be investigated. If an impoundment strategy is found feasible and economically justifiable for KBK, it should be the subject of a second phase of development.

vi. The existing BWDB-constructed road from Gazirhat to Terokhada should be rehabilitated to provide an all-season link between the eastern and western sides of the Project, and to link the Kalia area road system with that of Terokhada.

vii. A scheme for planting coconut trees on both sides of the embankment should be examined. This would have the objective of helping landless people who in return would take responsibility for maintaining the embankment sections, thus reducing the burden on BWDB.

2.7.2 Lessons for Future FCD/I Projects

i. Better studies of the internal hydrology of the project area are required before large FCD projects, to avoid problems of inadequately sized structures, incomplete drainage networks and siltation of waterways.

ii. In planning new FCD/I projects, the scope should be examined for reserving low-lying areas as permanent water bodies, and where possible augmenting their storage capacity by excavation and/or embankment. Such water bodies would provide a source of irrigation water (not available in quantity from other sources in the saline coastal zone) and could also play a major role in mitigating adverse impacts on capture fisheries.

iii. Where such a strategy for water supply is adopted:

- it should preferably be incorporated at the earliest planning stage, rather than added later when resistance from people already farming the reclaimed land is likely;

- reservoirs should be sized and operated as far as possible to provide a permanent stock of fish for local consumption and to assist in restocking other waters.

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3 HYDROLOGICAL IMPACT

3.1 INTRODUCTION

The pre-Project hydrological conditions in the KBK area, and the Project's objectives for transforming them, have been described in Chapter 2. Those objectives were to bring about major changes in the two key parameters of depth and duration of flooding. This Chapter describes the impact of the Project on these parameters. It also assesses the irrigation status of the Project area, in view of the Project's minor hydrological objectives for this parameter.

3.2 SOURCES OF DATA

The following reports and Project document were reviewed for hydrological data:

- Feasibility Report on Barnal-Silimpur-Kolabashukhali Project, Directorate of Special Projects, Bangladesh Water Development Board, Dhaka October 1977.

- Project Proforma Barnal-Silimpur-Kolabashukhali Project, BWDB Dhaka.

- Report on Evaluation Studies of DFC-1: Kolabashukhali Sub-Project, Engineering Science Limited, Dhaka November 1986.

- Bangladesh Drainage and Flood Control Project (Credit 864-80) Project Completion Report, FAO Investment Centre For the World Bank, Rome January 1989.

Information relevant to the Project were also collected during the RRA survey and on follow-up visits through discussions with BWDB officials and interviews with local people. The most important source of new quantified data, however, was the agricultural module of the PIE sample survey of agricultural households. This obtained details of pre- and post-Project flood\depth and duration, and of post-Project irrigation status, for all the plots of land operated by a random sample of 120 cultivators inside the Project and 60 in the control area. It is thus possible to compare both with/without and pre/post Project hydrological conditions.

3.3 ASSESSMENT OF HYDROLOGICAL IMPACTS

The Project impacts on hydrology have been assessed qualitatively in terms of impact on flood type within the Project and on the hydrology of the external areas, and quantitatively in terms of the changes in distribution of land area under different hydrological conditions as a result of the Project. An quantitative assessment has also been made of the hydrological comparability of the control area with pre-Project conditions in the protected area, as a guide to the validity of project-control area comparisons.

3.3.1 Impact on Flood Type

a) Impacts Within the Project

As noted in Chapter 2, the pre-Project flood type in KBK was a combination of types T (Tidal), M (Main river monsoon) and L (Local congestion), as defined in the FAP 12 Final Report (Appendix G, Volume 3). In the post-Project period, flood types T and M have been completely eliminated within the main flood embankment, and there have been no involuntary breaches (even in 1988, the year of national flood disaster) to permit their recurrence.

There has been considerable diminution in the incidence of flood type L within the Project area, but on the evidence of local statements the problem remains acute in some years and in some parts of the Project. Some respondents stated that congestion in the southern half of the Project were due to flows from the northern half, indicating failure to provide sufficient drainage capacity in the north, and/or insufficiently flexible operation to dispose of water promptly. Given the considerable tidal range (see Chapter 2), which means that outside water levels are usually low enough to permit drainage on a daily basis, the congestion problem is not as insoluble as in some projects studied by FAP 12.

b) Impacts Outside the Project

FAP 12 did not receive any reports of higher post-Project water levels or changes in inundation duration outside the Project, and in the absence of river gauging records there is no objective evidence for external impacts. It is likely, however, that there has been a cumulative impact of the numerous FCD projects in the South-West Region. KBK is part of a group of such projects just north of Khulna which also includes the completed Chenchuri Beel and Barakpur Projects and the Bhuter Beel Project now nearing completion. Studies elsewhere in Bangladesh indicate major externalities from such constellations of projects, and the impact in the South-West should be an early priority for modelling studies.

3.3.2 Impact on Flood Depth and Duration

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

The sample households were selected by two stage random sampling; the first stage sampling unit was the mouza (revenue village), and the second stage units were households in the selected mouzas. The farm household survey covers a sample of 122.80 ha. of cultivated land in the impacted/protected area and 64.78 ha. in the control area. The results of the survey revealed the following project impacts.

a) Flood Depth

In the pre-project situation, the Project area was strongly influenced by tidal action, because the area is surrounded by tidal rivers on all sides. A considerable amount of river water entered and left the area twice daily. In addition, the monsoon rain water of the area was added to this volume and the total accumulated water could not be drained out properly by gravity flow due to higher river levels, causing acute drainage congestion resulted in about 40 per cent of the area to be inundated almost a half year duration.

The project has succeeded in protecting the area from high tides and monsoon floods, in reducing soil salinity by preventing saline intrusion and in increasing security against tidal river level fluctuation. The area of previously very low land has been converted to effectively higher land with reduced monsoon season water levels; land at MPO levels of F4 and F3 has been converted to F2, and F2 has been converted F1 and F0. Flood depths in the pre-project and post-project situation are shown in Table 3.1 and Figure 3.1. The impact can be summarized as follows:

- in the protected area cultivated land subject to the three shallowest depths of normal flooding (less than 90 cm.) increased considerably, from 34.22 ha. (27.9 per cent of sample area) to 69.34 ha. (56.4 per cent), with a corresponding decrease in the area under the deeper flood depths (more than 90 cm.) from 88.58 ha. (72.1 per cent of sample area) to 53.46 ha. (43.6 per cent) - a significant positive impact;

- in the control area there was also some improvement in flood depths over the same time span, but of smaller proportions. Cultivated land under the three shallowest flood depths increased from 33.7 per cent of the total to 42.9 per cent, with a corresponding decrease in the area under the deeper flood depths (more than 90 cm.). This may reflect the difficulties in selecting a control area for Kolabashukhali, the only one available being in an adjacent incomplete project which may have already been receiving some protection;

b) Impact on Flood Duration

Table 3.2 and Figure 3.2 show that cultivated lands subject to shorter inundation periods (less than two months) increased from 14.15 ha (11.4 per cent of the sample) to 42.34 ha (34.5 per cent), with a corresponding decrease in land subject to longer inundation - a positive impact in the protected area. The control area shows very minor changes in the duration of inundation in cultivated lands and these seem not to be significant. Despite the continuing congestion problems within the protected area, it is clear that excluding the tidal and main river floods enables the local rainwater inundation to be cleared faster than would be the case without the Project.

3.3.3 Flood Damage in 1988

From the PIE survey, in the 1988 flood 46 per cent of households in the protected area suffered damage, compared with 73 per cent in the control area. The reduction in number of households affected is noteworthy because in most of the projects studied by FAP 12 PIEs the notionally protected area suffered more due to property accumulation and breaches of the embankments.

Those households affected by homestead flooding in 1988 experienced greater flood depth and longer duration of flooding than those in the control area (see FAP 12 Final Report, Appendix M); this was probably due to the congestion which led to the embankment cuts noted in Chapter 2. However, the mean damage per affected household was only 94 per cent of that in the control area.

Table 3.1 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 (%)	4.60 (3.7)	10.04 (8.2)	5.44 (4.5)	- (-)	- (-)	- (-)	4.22 (6.5)	5.08 (7.8)	0.86 (1.3)
Medium High (%)	6.70 (5.5)	22.40 (18.2)	15.70 (12.7)	- (-)	- (-)	- (-)	5.61 (8.6)	7.57 (11.7)	1.96 (3.1)
Medium Low (%)	22.92 (18.7)	36.90 (30.0)	13.98 (11.3)	- (-)	- (-)	- (-)	12.03 (18.6)	15.13 (23.4)	3.10 (4.8)
Low (%)	52.47 (42.7)	47.59 (38.8)	-4.88 (-3.9)	- (-)	- (-)	- (-)	26.87 (41.5)	25.34 (39.1)	-1.53 (-2.4)
Very Low (%)	36.11 (29.4)	5.87 (4.8)	-30.24 (-24.6)	- (-)	- (-)	- (-)	16.05 (24.8)	11.66 (18.0)	-4.39 (-6.8)
Total (%)	122.80 (100.0)	122.80 (100.0)	- (-)	- (-)	- (-)	- (-)	64.78 (100.0)	64.78 (100.0)	- (-)

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

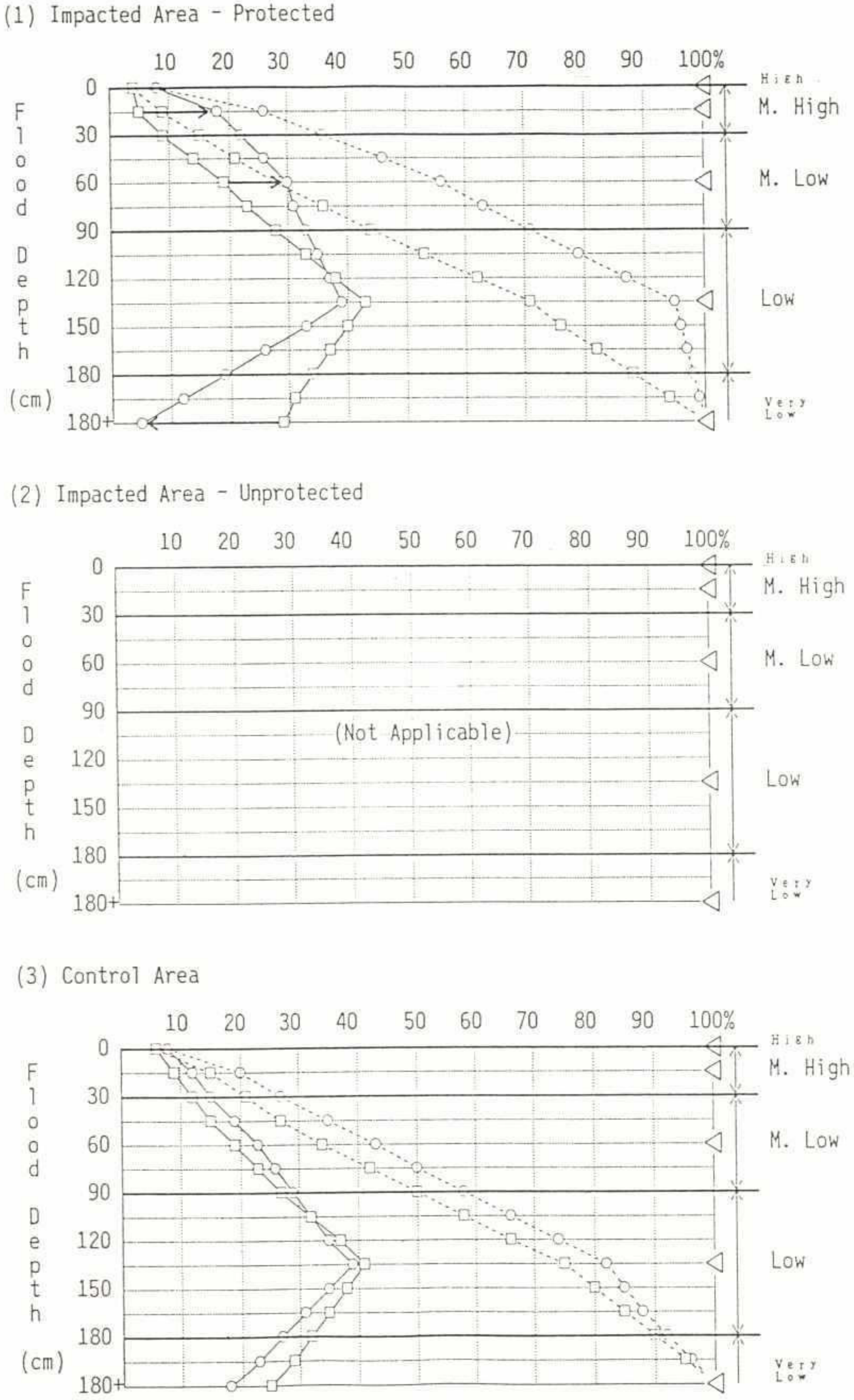
Source: PIE Farm Household Survey

Table 3.2 Cultivated Land by Duration of Inundation
(Unit: ha.)

Inundation Duaration (month)	Impacted Area						Control Area		
	Protected Area			Unprotected Area					
	Before	Present	Increase	Before	Present	Increase	Before	Present	Increase
0 (%)	5.20 (4.2)	29.55 (24.1)	24.35 (19.9)	- (-)	- (-)	- (-)	4.27 (6.6)	5.09 (7.9)	0.82 (1.3)
0 - 1 (%)	2.33 (1.9)	4.29 (3.5)	1.96 (1.6)	- (-)	- (-)	- (-)	1.23 (1.9)	3.07 (4.7)	1.84 (2.8)
1 - 2 (%)	6.62 (5.4)	8.50 (6.9)	1.88 (1.5)	- (-)	- (-)	- (-)	5.45 (8.4)	5.96 (9.2)	0.51 (0.8)
2 - 3 (%)	7.16 (5.8)	11.34 (9.2)	4.18 (3.4)	- (-)	- (-)	- (-)	7.37 (11.4)	7.07 (10.9)	-0.30 (-0.5)
3 - 4 (%)	12.85 (10.5)	12.98 (10.6)	0.13 (0.1)	- (-)	- (-)	- (-)	9.19 (14.2)	7.80 (12.0)	-1.39 (-2.2)
4 - 5 (%)	26.51 (21.6)	8.02 (6.5)	-18.49 (-15.1)	- (-)	- (-)	- (-)	13.51 (20.8)	11.63 (18.0)	-1.88 (-2.8)
5 - 6 (%)	10.81 (8.8)	16.42 (13.4)	5.61 (4.6)	- (-)	- (-)	- (-)	7.83 (12.1)	7.49 (11.6)	-0.34 (-0.5)
6 and over (%)	51.32 (41.8)	31.70 (25.8)	-19.62 (-16.0)	- (-)	- (-)	- (-)	15.93 (24.6)	16.67 (25.7)	0.74 (1.1)
Total (%)	122.80 (100.0)	122.80 (100.0)	- (-)	- (-)	- (-)	- (-)	64.78 (100.0)	64.78 (100.0)	- (-)

Source: PIE Farm Household Survey

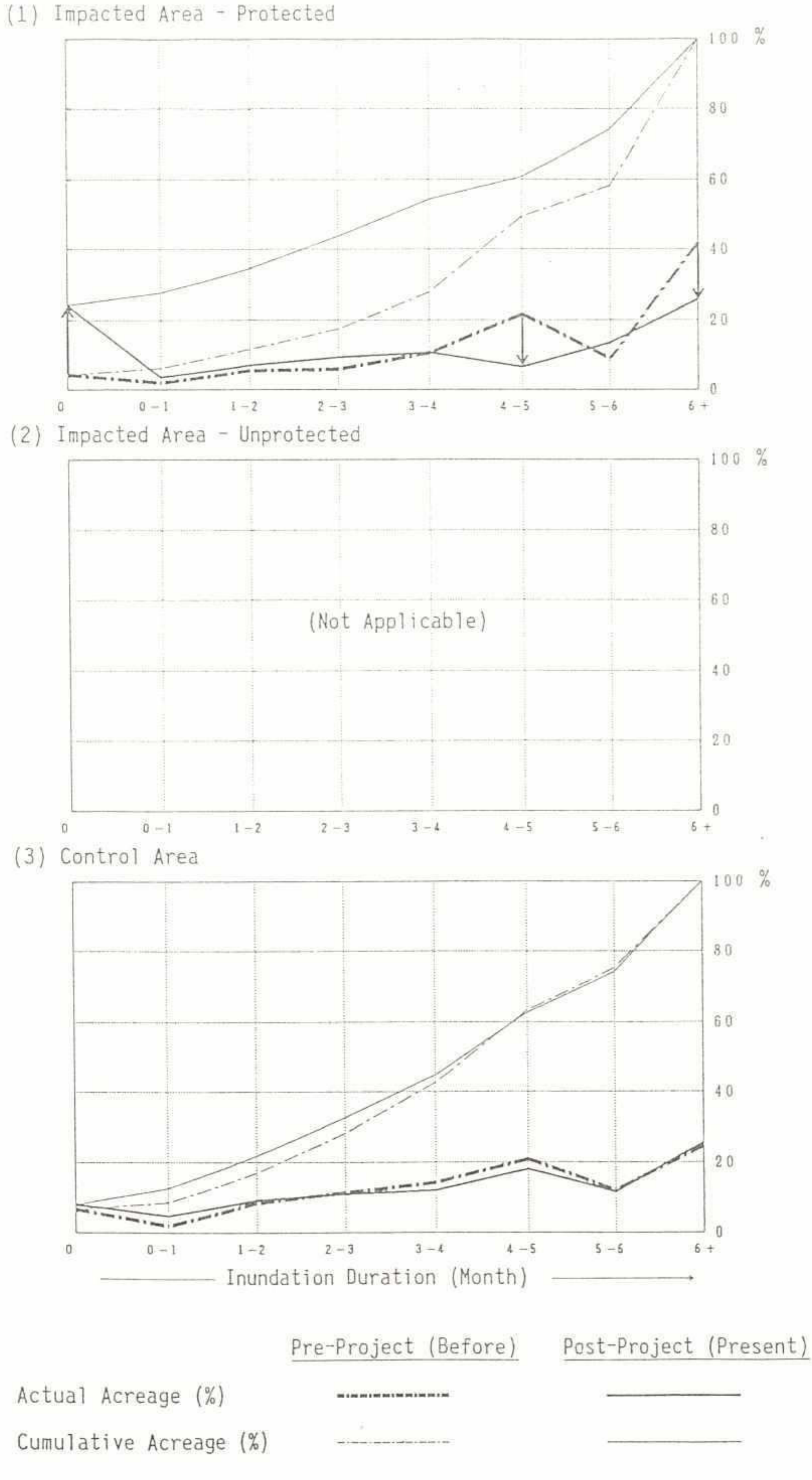
Figure 3.1 **Cultivated Land by Flood Depth**



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

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

Figure 3.2 Cultivated Land by Inundation Duration



3.3.4 Impact on Irrigation

The Project had a subsidiary objective of developing irrigation, but surface water irrigation development has been very limited because of the unchanged main river regime which permits upstream penetration of saline tidal water in the dry season. The demand for irrigation is however considerable. All the flushing and drainage sluices are being used for flushing to admit irrigation water from the surrounding rivers to the existing khals and to the beel depressions. However, there are actual and potential conflicts between cultivators and shrimp farmers over operation of the sluices, which have in the past led to sluices being opened at inappropriate times, with consequent crop damage by saline water.

On the other hand, groundwater irrigation is likewise limited to a small area in the north, since the southern part of the Project lies near the boundary of coastal saline groundwater intrusion, and wells are liable to cease yielding and/or to produce gas. Thus, there seems little scope for widespread tubewell irrigation in the Project. Tables 3.3 to 3.5 and Figure 3.3 give the post-project irrigation condition in the impacted and the control areas. The salient feature is the very slight development of irrigation in both protected and control area; total irrigated area for all seasons is 5.7 per cent of the land cultivated by the sampled farm households in the protected area, and 4.0 per cent in the control area. The very small sample size for irrigated area means that no particular reliance can be placed on the breakdown of area by crops or by means of irrigation.

3.5.4 Hydrological Comparability of Control Area

In order to evaluate the appropriateness of the selected control area as a guide to without-project conditions, correlation coefficients for the pre-project conditions in the protected and control areas were calculated for flood depth and duration. The results are:

Flood Depth (n=5) :	R = 0.990
Inundation Duration (n=8):	R = 0.909

Since a value of R = 1.0 would indicate a perfect match between protected and control areas, the correlation coefficients give quite satisfactory justification for selection of the control area in the farm household survey, even though the sample sizes for the test are rather small.

3.6 PROJECT SUCCESS IN ACHIEVING OBJECTIVES

The Project has to a considerable extent achieved its intended hydrological impacts. It has succeeded in protecting the area from high tides and monsoon floods, in reducing soil salinity by preventing saline intrusion, and in increasing security against tidal river level fluctuations.

In addition to improving the hydrological conditions for agriculture on land which was already cultivated, the Project has permitted the extension of cultivation into a significant area of previously uncultivable land. As noted above, the household survey could not detect this impact, but RRA results suggested that as much as 5000 ha. may have become available; as a minimum, it would appear that the Project target of an incremental 3800 ha. has been achieved. Hence, KBK has functioned effectively as a land reclamation project. Flood durations have also been reduced somewhat, though there is still a substantial area under water for 5 or more months.

Table 3.3 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.	-	0.82	-	-	-	0.82	-	-	-	-	-	-	-	-	-	-	-	-
	Irr. A.	-	0.82	-	-	-	0.82	-	-	-	-	-	-	-	-	-	-	-	-
	(%)	-	(100)	-	-	-	(100)	-	-	-	-	-	-	-	-	-	-	-	-
Aus, Total	Crp. A.	-	0.82	-	-	-	0.82	-	-	-	-	-	-	-	-	-	-	-	-
	Irr. A.	-	0.82	-	-	-	0.82	-	-	-	-	-	-	-	-	-	-	-	-
	(%)	-	(100)	-	-	-	(100)	-	-	-	-	-	-	-	-	-	-	-	-
Aman, T, LV	Crp. A.	-	-	-	-	-	-	-	-	-	-	-	-	-	0.21	-	-	-	0.21
	Irr. A.	-	-	-	-	-	-	-	-	-	-	-	-	-	0.21	-	-	-	0.21
	(%)	-	-	-	-	-	-	-	-	-	-	-	-	-	(100)	-	-	-	(100)
Aman, Total	Crp. A.	-	-	-	-	-	-	-	-	-	-	-	-	-	0.21	-	-	-	9.02
	Irr. A.	-	-	-	-	-	-	-	-	-	-	-	-	-	0.21	-	-	-	2.36
	(%)	-	-	-	-	-	-	-	-	-	-	-	-	-	(100)	-	-	-	(26.2)
Boro, LV	Crp. A.	-	-	1.21	3.26	-	4.47	-	-	-	-	-	-	-	-	3.97	3.59	-	7.56
	Irr. A.	-	-	0.06	0.38	-	0.44	-	-	-	-	-	-	-	-	0.40	0.50	-	0.90
	(%)	-	-	(5.0)	(11.7)	-	(9.8)	-	-	-	-	-	-	-	-	(10.1)	(13.9)	-	(11.9)
Boro, HYV	Crp. A.	0.93	1.55	2.14	1.15	-	5.77	-	-	-	-	-	-	-	-	1.46	-	-	1.46
	Irr. A.	0.93	1.55	2.14	0.90	-	5.52	-	-	-	-	-	-	-	-	1.46	-	-	1.46
	(%)	(100)	(100)	(100)	(78.3)	-	(95.7)	-	-	-	-	-	-	-	-	(100)	-	-	(100)
Wheat	Crp. A.	0.28	-	-	-	-	0.28	-	-	-	-	-	-	-	-	-	-	-	-
	Irr. A.	0.28	-	-	-	-	0.28	-	-	-	-	-	-	-	-	-	-	-	-
	(%)	(100)	-	-	-	-	(100)	-	-	-	-	-	-	-	-	-	-	-	-
Rabi/Boro, Total	Crp. A.	1.21	1.55	3.35	4.41	-	10.52	-	-	-	-	-	-	-	-	5.43	3.59	-	0.21
	Irr. A.	1.21	1.55	2.20	1.28	-	6.24	-	-	-	-	-	-	-	-	1.86	0.50	-	0.21
	(%)	(100)	(100)	(65.7)	(29.0)	-	(59.3)	-	-	-	-	-	-	-	-	(34.3)	(13.9)	-	(100)
Grand Total	Crp. A.	1.21	2.37	3.35	4.41	-	11.34	-	-	-	-	-	-	-	0.21	5.43	3.59	-	9.23
	Irr. A.	1.21	2.37	2.20	1.28	-	7.06	-	-	-	-	-	-	-	0.21	1.86	0.50	-	2.57
	(%)	(100)	(100)	(65.7)	(29.0)	-	(62.3)	-	-	-	-	-	-	-	(100)	(34.3)	(13.9)	-	(27.8)

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

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

Source: PIE Farm Household Survey

Table 3.4 Irrigated Area by Flood Depth and Method of Irrigation
(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.	-	0.82	-	-	0.82	-	-	-	-	-	-	-	-	-	-
	M.L.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Low	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	V.L.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Total	-	0.82	-	-	0.82	-	-	-	-	-	-	-	-	-	-
Aman	High	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	M.H.	-	-	-	-	-	-	-	-	-	-	-	-	-	0.21	0.21
	M.L.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Low	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	V.L.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Total	-	-	-	-	-	-	-	-	-	-	-	-	-	0.21	0.21
Rabi/Boro	High	-	1.21	-	-	1.21	-	-	-	-	-	-	-	-	-	-
	M.H.	-	1.55	-	-	1.55	-	-	-	-	-	-	-	-	-	-
	M.L.	-	2.14	-	0.06	2.20	-	-	-	-	-	-	1.14	0.32	0.40	1.86
	Low	0.39	0.51	-	0.38	1.28	-	-	-	-	-	-	0.16	-	0.34	0.50
	V.L.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Total	0.39	5.41	-	0.44	6.24	-	-	-	-	-	-	1.30	0.32	0.74	2.36
Total	High	-	1.21	-	-	1.21	-	-	-	-	-	-	-	-	-	-
	M.H.	-	2.37	-	-	2.37	-	-	-	-	-	-	-	-	0.21	0.21
	M.L.	-	2.14	-	0.06	2.20	-	-	-	-	-	-	1.14	0.32	0.40	1.86
	Low	0.39	0.51	-	0.38	1.28	-	-	-	-	-	-	0.16	-	0.34	0.50
	V.L.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Total	0.39	6.23	-	0.44	7.06	-	-	-	-	-	-	1.30	0.32	0.95	2.57

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 3.5 **Irrigated Area by Method and Crop Season (Unit: ha.)**

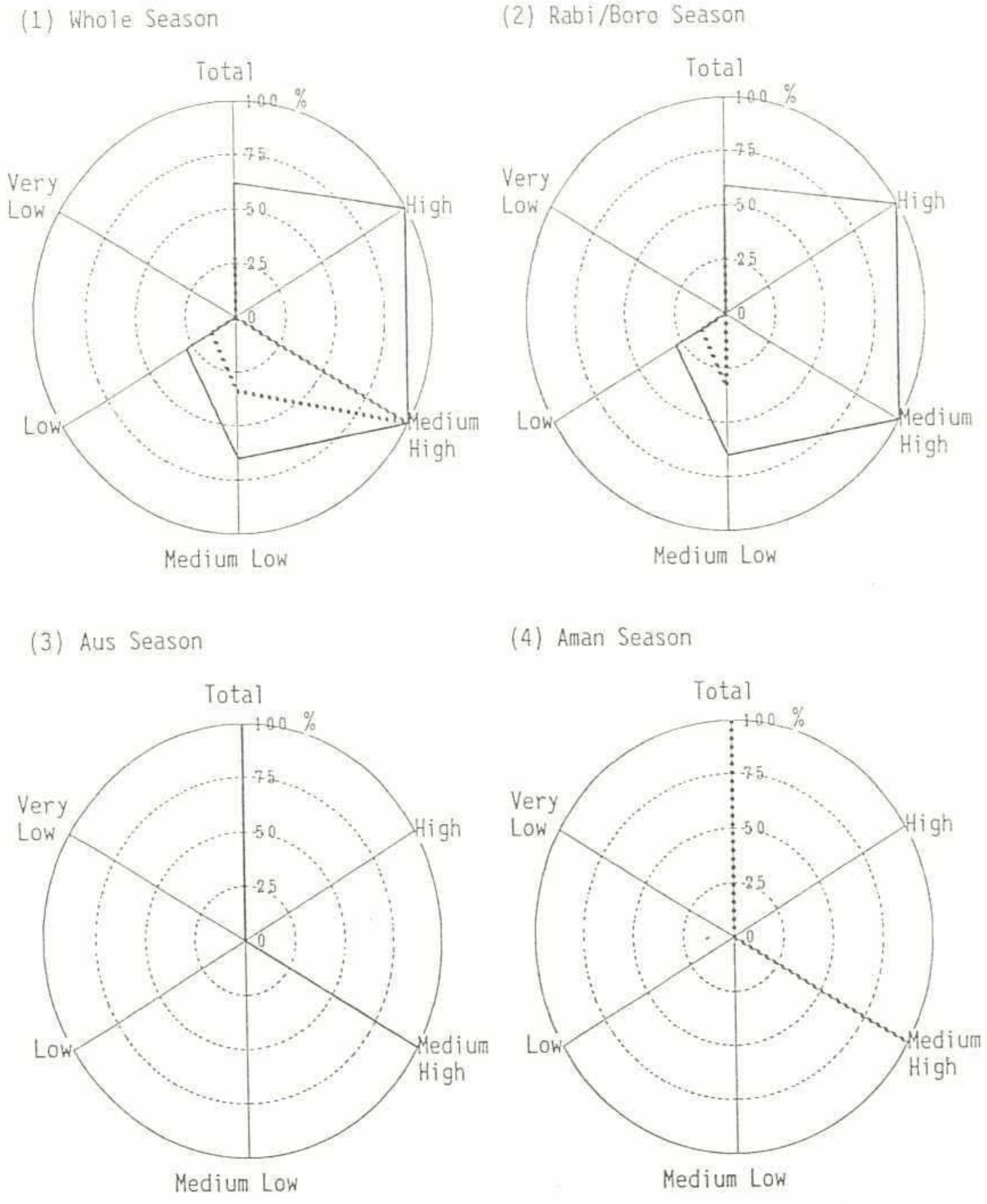
Crop		Impacted Area										Control Area				
		Protected Area					Unprotected Area									
		DTW	STW	LLP	Ind.	Total	DTW	STW	LLP	Ind.	Total	DTW	STW	LLP	Ind.	Total
Aus. T. LV	Irr. A.	-	0.82	-	-	0.82	-	-	-	-	-	-	-	-	-	-
	(%)	(-)	(100)	(-)	(-)	(100)	-	-	-	-	-	-	-	-	-	-
Aus. Total	Irr. A.	-	0.82	-	-	0.82	-	-	-	-	-	-	-	-	-	-
	(%)	(-)	(100)	(-)	(-)	(100)	-	-	-	-	-	-	-	-	-	-
Aman. T. LV	Irr. A.	-	-	-	-	-	-	-	-	-	-	-	-	-	0.21	0.21
	(%)	-	-	-	-	-	-	-	-	-	-	(-)	(-)	(-)	(100)	(100)
Aman. Total	Irr. A.	-	-	-	-	-	-	-	-	-	-	-	-	-	0.21	0.21
	(%)	-	-	-	-	-	-	-	-	-	-	-	-	-	(100)	(100)
Boro. LV	Irr. A.	-	-	-	0.44	0.44	-	-	-	-	-	-	0.16	-	0.74	0.90
	(%)	(-)	(-)	(-)	(100)	(100)	-	-	-	-	-	(-)	(17.8)	(-)	(82.2)	(100)
Boro. HYV	Irr. A.	0.39	5.13	-	-	5.52	-	-	-	-	-	-	1.14	0.32	-	1.46
	(%)	(7.1)	(92.9)	(-)	(-)	(100)	-	-	-	-	-	(-)	(78.1)	(21.9)	(-)	(100)
Wheat	Irr. A.	-	0.28	-	-	0.28	-	-	-	-	-	-	-	-	-	-
	(%)	(-)	(100)	-	-	(100)	-	-	-	-	-	-	-	-	-	-
Rabi/Boro. Total	Irr. A.	0.39	5.41	-	0.44	6.24	-	-	-	-	-	-	1.30	0.32	0.74	2.36
	(%)	(6.3)	(86.7)	(-)	(7.1)	(100)	-	-	-	-	-	(-)	(55.1)	(13.6)	(31.4)	(100)
Grand Total	Irr. A.	0.39	6.23	-	0.44	7.06	-	-	-	-	-	-	1.30	0.32	0.95	2.57
	(%)	(5.5)	(88.2)	-	(6.2)	(100)	-	-	-	-	-	(-)	(50.6)	(12.5)	(37.0)	(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 3.3 Cropped Area under Irrigation by Flood Depth and Season



	Total Cropped Area (ha)				Legend
	Whole Sea.	Rabi/Boro	Aus	Aman	
Protected	11.34	10.52	0.82	-	————
Unprotected	n.a.	n.a.	n.a.	n.a.	
Control	9.23	9.02	-	0.21	············

Because much of the Project is a series of basins, monsoon season drainage is limited. Coupled with the inadequacy of the drainage system this still results in acute drainage congestion at the height of the monsoon season, and at other times of heavy rainfall.

There is relatively little irrigation in the Project area (only 6 percent of land operated by sample households) but this is more than in the control area. Since the Project there appears to have been a small expansion of STW irrigation in both areas, but this is probably only part of the national trend, and the largest area of irrigation is managed by a traditional surface water system based on a tidal khal and predating the Project.

4 OPERATION AND MAINTENANCE

4.1 PRE-PROJECT SITUATION

Prior to the BWDB Project at KBK, there were already bunds and earth roads along much of the riverbanks surrounding the Project area. These reflected initiatives by local government, including those made under FFW programmes, to protect the area from tidal flooding. However, these bunds were relatively low and did not provide full protection. In addition, there was some local water management by the public which has persisted up to the present (1991).

The Benda Khal, near Kalia at the northern end of the project, has no regulator but is managed by local residents who close it with a cross-dam in the monsoon. It is used to admit water from the Nabaganga river during the Rabi and early Kharif seasons for irrigation of HYV Boro, water being supplied to the land both by Low-Lift Pumps (LLP) and by gravity at high tide. Irrigation was observed to be still in progress during the RRA visit in April 1991. Irrigation with river water further south is risky after February, due to increasing salinity levels in the rivers, though there is a small area of minor irrigation supporting HYV Boro production on the north-east side of the Kola Beel, drawing water from the Bhujniar Khal with LLPs.

These minor irrigation and water regulation developments show that local people can manage irrigation and maintain their system to prevent flooding, and could provide a model for local participation in managing the BWDB structures. At the time of construction the local people around the Benda Khal refused to let BWDB close off their khal, since it was proposed to have a permanent closure. Subsequently local opinion has moved in favour of a regulator (which would avoid the work of building and breaking the cross-dam), but it is not certain that this would be better managed or as sustainable.

4.2 INSTITUTIONAL FRAMEWORK

4.2.1 Institutions for Project Operation

There is no O&M Manual specifically for KBK, but an O&M Manual for the Coastal Embankment Project (Leedshill DeLeuw, 1968) was supplied to BWDB by the then consultants, and this is supposed to also be followed in the KBK project.

Following the CEP O&M manual, sluices should be operated so as to remove excess monsoon rainfall and prevent saline water from entering the polder. Flushing sluices and drainage sluices, when the latter are properly designed for reverse flow, should be operated to bring fresh water into the protected area in accordance with the written schedules and specifications of the sluice operation committee.

The East Bengal Embankment and Drainage Act 1952, as amended in 1962 stated:

> "Sluices constructed in any public embankment shall be opened or shut only by or with the general or special permission of the Executive Engineer or of the officer in the immediate charge of the embankment, under such orders, either general or special as he may receive from the Executive Engineer".

According to the CEP O&M manual, the officer in immediate charge of the embankment in KBK project is the Sub-Division Engineer (SDE). He may delegate his authority to the Sectional Officer (SO). The manual further specifies:

"The SDE shall organise the sluice committee, which shall consist of:

i) The BWDB Sectional Officer assigned for operation and maintenance of the sluice, or his representative;

ii) Union Parishad Chairman, or his authorised representative; and

iii) Block Supervisor of the Agriculture Department."

The next immediate charge is with the Work Assistant who is authorised to operate the sluice in emergency conditions without a sluice committee meeting if the structure or crops are suddenly threatened. Each sluice/regulator should have one Sluice Khalashi (operator or caretaker) for guarding and taking care of the sluice. Quarterly meetings of the sluice committee should be scheduled by the SDE. These contacts with the landowners can be useful to anticipate troubles, and thus gain the cooperation of the local people.

4.2.2 Agricultural Support Institutions

The Staff Appraisal Report for KBK (IBRD, 1978) mentioned that the DAE would be responsible for providing agricultural extension services to fulfil the agricultural development targets of the project. They would also arrange construction of extension staff quarters, training centres and procurement of vehicles and necessary equipment for a training centre. The Training centre has not yet been built and training has not been imparted to the target group as was envisaged in the project document.

During the RRA the FAP 12 field team received the impression that agricultural extension officers scarcely visited the farmers and that services were in general inadequate, which might have reduced the level of project effectiveness. The only evidence of extension activity seen during the RRA was a pesticide demonstration near Kalia, which had been set up by a commercial firm. There has clearly been none of the extra extension effort envisaged by the SAR.

4.3 OPERATION AND WATER MANAGEMENT

4.3.1 Regulators, Sluices and Public Cuts

The need in KBK Project is both for drainage during the monsoon and for inflows of water when salinity levels are low enough to permit some irrigation. However, all the existing regulators and sluices, which were constructed for a single function (either drainage or flushing), are being used both for drainage and flushing purposes. This operation is causing damage to the structures (see Chapter 2).

There are operating problems with a number of regulators because of poor site investigations, design or construction. The Madhupur Khal drainage sluice has settled down by about 7"-8" and has been out of operation during 1989-91. The Harikhali Khal drainage sluice also settled by about 6" but has been brought back into operation after minor repair.

The Mathabhanga regulator is still under construction, and was not in operation in 1991. Work on the Bhumbhug regulator, which is still under construction, has stopped because of problems with the foundations. The Lohargati Flushing sluice (1 vent) is completely abandoned and almost buried in the soil.

About 75 per cent of the sluices gates are leaking profusely, due to deterioration of the seals, causing saline water intrusion into the project area. In general, operation of the individual sluices is not well coordinated with agricultural needs and there may be a need for control structures within the Project since there is a complex drainage pattern between interlinked beels.

In 1988 there were six public cuts to relieve internal drainage congestion, three of which were between mileage 44 and 47. However, these have been repaired and public cuts do not appear to be a regular occurrence. If public cuts were only needed in 1988, this may be an acceptable operational response to severe drainage congestion.

4.3.2 Irrigation

All the flushing and drainage sluices are being used for flushing to provide irrigation water from the rivers to the existing section of the khals and to the beel depressions. There are actual and potential conflicts between cultivators and shrimp farmers over operation of the sluices, which have in the past led to sluices being opened at inappropriate times, with consequent crop damage by saline water.

4.3.3 Operational practice and social assessment

The institutional framework proposed for the Project and described in Section 4.2 provides for multiple officers making decisions without direct responsibility to the operator on the ground. In practice, there are sluice committees for almost every sluice, as provided in the O&M manual, but they were found to be neither properly formed nor functioning. In particular, farmers complained that the sluice committees did not represent the interests of all persons affected by sluice operations, with the result that sluices were operated in ways which adversely affected large numbers of people. Farmers in the basin of the Bashukhali Khal in particular complained of the sluice being opened in the early Kharif period, when the Atai River is highly saline, with severe damage to the Boro rice crop. This opening is thought to be done at the behest of influential shrimp farmers to facilitate catching fry for stocking shrimp ponds.

In addition there is a conflict of interest between the farmers on relatively higher land in the northern part of the project (under Kalia Upazila), and those in the low lying Kola Beel area, over both drainage and water retention. The uncontrolled drainage channels which link these two areas mean that the upper drainage basin may be over-drained so that the lower beel is not flooded. There is a limit to the possibility of improving operation without modifying the project infrastructure.

4.4 MAINTENANCE OF THE PROJECT

4.4.1 Technical assessment

The state of repair of the project structures during the 1991 monsoon is given in Table 2.1. About 30 per cent of the length of the embankment needed repairs and re-sectioning at the time of fieldwork (1991). According to BWDB seven stretches of the embankment totalling 15 km (9.5 miles) have persistent (almost annual) problems of 'ghogs' due mainly to crab and rat holes. During the three flood seasons 1988-1990 natural breaches due to ghogs were reported at two locations: one of four miles at mileage 30-34, and a smaller one at mileage 44.5-45. These had been repaired during 1989 under Flood Damage Repair works.

The network of drainage channels has almost disappeared in most places and does not reach into the lowest parts of the beels. Almost all the outfall channels on the river side of the regulators are badly silted up.

The access road between Gazirhat and Terokhada (constructed by BWDB) is severely damaged at several places, particularly between Barasat school and Katenga Khal culvert. The approaches to the culverts on this road are badly damaged. There is no culvert on an existing channel near Bamandanga village and on Hatiar Khal, where people presently use bamboo bridges. This road was constructed by BWDB, although it is unclear why it was built since excavation of the 'dead' Chitra river might have maintained communications (which are mainly by boat) and could have improved drainage facilities.

There is moderate to severe erosion of the river banks at the following locations, causing damage to land and property:

i) River Bhairab at Sulpur and at Laskarpur - threat to the embankment;

ii) River Nabaganga at Madhabpasa and at Bara Kalia; and

iii) River Chitra at Terokhada - For a length of 1 km and threat to the Upazila Health Centre and Upazila Chairman's office.

A retired embankment at mileage 7-8 was built in 1989 because of erosion, and there are proposals to retire the embankment at two other locations.

4.4.2 Institutional and social assessment

As detailed in the CEP O&M manual, before preventive or corrective maintenance starts the problem must be found by inspection. Inspection consists of looking at a structure, and then having the experience to identify a need for maintenance. Once the repair work is complete, it must be re-inspected, and so the cycle is repeated.

In order to ensure an orderly flow of information on the operation and maintenance of the completed polder, and to keep a firm control of the O&M programme, a standard reporting system has been designed (see Table 4.1). Some items follow prescribed forms and some are written or verbal.

During the last few years preventive and emergency repair/replacement type of O&M was undertaken by the BWDB Division Office at Khulna. However, BWDB in general does not practice any well defined or prescribed inspection and management system, and KBK project is no exception. The reporting structure specified in the O&M manual may have been excessively elaborate, given the lack of funds for field visits, but on the other hand BWDB has manpower and resources available but has not developed a clear programme for monitoring and maintenance. Unlike operation, where the problem is of uncoordinated and conflicting local influence, there is no public participation in the maintenance of the project with the exception of the operation and maintenance of the Benda Khal cross-bund. There is no system of routine maintenance for the Project, only repairs following damage.

Table 4.1 Operation and Maintenance Reporting System

Office	Reporting Item	Inspection Interval	Reporting Interval	Mode of reporting	Submitted to
P.D.(SE)	Operation and Maintenance	Annually	Annually	Written	CE(SZ)
XEN	"	Quarterly	Quarterly	Prescribed form	PD,CE(SZ)
SDE	Operation	Twice monthly	Monthly	"	XEN, PD, CE
SDE	Maintenance	"	"	"	XEN, PD
S.O.	O&M	Weekly	Twice monthly	"	SDE,XEN
Work Assistant	Maintenance	2 per week	Weekly	Written	SO
Sluice Khalashi	"	2 per week	2 per week	Verbal	WA

Source : O&M Manual of the Coastal Embankment Project

4.5 O&M COSTS

The combined O&M structure of Kolabashukhali Project has the equivalent of 52 staff; this includes KBK's share of the office of the O&M Division. It has been assumed (on the advice of the XEN Khulna O&M Division 1) that KBK covers one fourth of the Division's area of jurisdiction. This establishment costs Tk 170,000 per month or Tk 2.04 million a year (Tk 80 per ha benefited). However, almost 50 per cent of this establishment are office and miscellaneous non-field staff (including an Imam and Moazzen), and a further six are mechanical staff, despite a lack of pumps or other machinery in the project (except the speedboat which is needed for access to most of the structures and embankment). It would be possible to make considerable savings on staff costs which would help to cover routine maintenance requirements, particularly if the 11 khalashis were made part time or were retrained to provide supervision and/or assistance in routine maintenance.

In the last three years (1988/89-1990/91) substantial sums have been spent on major repairs and embankment resectioning. Some 57 per cent of the embankment has been resectioned under FFW programmes, averaging 16.4 km a year at a cost of 624.6 metric tons of wheat a year. This implies a five year resectioning cycle for the whole embankment. Routine maintenance programmes funded out of the establishment budget, or even from part of the FFW resources, could free resources for other investments.

In particular, in 1988/89 a large sum (Tk 10.71 million) was spent on flood damage repair. However, Tk 7 million went on building two regulators (Bhumbhug and Mathabhanga), neither of which is yet completed. The estimated cost escalation for Bhumbhag regulator in the IDA FDR submission for 1990/91 was 60 per cent due to foundation problems with the sluice. The second highest repair cost was bank protection using porcupines at a cost of Tk 1.25 million per km for 1.26 km., although building a retired embankment at the same time appeared to have a lower cost per kilometre.

Hence, the strict O&M related costs of KBK can be approximated to the FFW and establishment costs at Tk 4.67 million and Tk 2.04 million a year respectively (1991 financial prices). This very roughly amounts to Tk 6.25 million a year in economic prices (based on the conversion factor for wheat and the specific conversion factor for skilled labour).

4.6 CONCLUSIONS

Two morphological factors have important implications for management of this, and other FCD projects:

- river bank erosion, which will require either continuing investments in bank protection to avoid breaches of the embankment and maintain its effectiveness, or retirement of parts of the embankment; and
- river bed siltation, which results in raised water levels and may require a continual process of embankment raising in the future to maintain the level of protection initially provided and to which project inhabitants become adjusted.

The key institutions for efficient operation of the sluices are the sluice committees, but some of these do not exist, and all the others fail to represent the full range of interests in the areas served by their respective sluices. Hence operation of the sluices, both for drainage and irrigation needs, is not well coordinated with agricultural requirements.

There is no project management committee to coordinate operation of the entire polder and provide a forum for consulting the elected representatives of the project population. Such a committee is needed, for example to resolve conflicting interests in sluice operation between farmers and fishermen.

There has been no coordination between the development institutions responsible for and active in the project area: BWDB, BRDB, BADC, DAE, Roads and Highways.

The extension and advisory services of the Departments of Agriculture, Livestock and Fisheries should be strengthened and reorganised to assist the population of KBK to respond to improved conditions. Preferably in new FCD/I projects such reorganisation should occur at the time of completion and should include an integrated structure for the entire project.

An institutional structure (project management organisation) should be created for effective liaison between BWDB and all sections of the community for planning and operation of the project. This should include, as a minimum:

- reorganised water user groups/sluice committees representing all sections of the community with an interest in a drainage sub-basin and sluice; and

- a project-level committee on which Upazila officers and BWDB technical staff would sit to liaise over system management.

The management structure could also contain intermediate levels (between project and sluices) if these were found necessary.

5 AGRICULTURE

5.1 PRE PROJECT CONDITIONS

The Kolabasukhali Project is situated in FAO/UNDP Agroecological Region 14 and in the Gopalganj Khulna Beel physiographic unit. This is a low lying area between the Ganges River Plains and Ganges Tidal Flood Plain. The detailed project location has been described in Chapter 1, and its hydrological characteristics in Chapter 2.

The protected area of the project covers 22,672 ha. (Feasibility Report). Of this about 20 per cent was below 2 ft. PWD datum and could not be cultivated pre-Project. The lowest parts (below 0.5 ft PWD) were too deeply inundated even for deep-water Aman, but the majority could have been cropped to B Aman if there had been a dry period long enough for land preparation. The lack of a dry period was a natural consequence of the daily tidal flooding regime characteristic of the area.

Above the uncultivable areas lay a zone of land at 2 - 4 ft. PWD, covering about 43 per cent of the Project, in most of which B Aman was grown in most years. Cropping in the lower half of this zone was risky, and these areas had been brought under cultivation by local reclamation efforts using small dikes and flap gates to close the creeks and rivulets and enhance low tide drainage.

Above 4 ft. PWD, B Aman was increasingly replaced by B Aus/Aman, as inundation levels became shallow enough for there to be a chance of harvesting the Aus before it was overtopped. On the higher lands in this zone, Aus/Aman was followed by rabi crops, and a little Local T Aman was grown. The Aus/Aman zone formed about 24 per cent of the protected area. The highest land, above 8 ft PWD, was mainly used for houses, roads and high value crops such as betel leaf.

Crop yields were low. The Feasibility Report estimated mean paddy yields to be about 1.57 mt/ha (17 md./ac.), broadly in agreement with FAP 12 RRA observations in April 1991 which estimated yields of B Aman and Aus/Aman, the major crops in the area, at 1.04 and 1.79 mt/ha respectively. The Feasibility Report attributes the low yields to:

- insufficient drainage in the lower areas;
- salt water intrusion in March to June;
- dry spells during the wet season.

It was estimated that removal of these problems would raise yields by 20 to 30 per cent. As a result of the insecurity of cropping conditions, input use was very low. The use of fertilizer was restricted to urea only, and other modern input use was also low.

5.2 PROJECT OBJECTIVES

The PP does not give any quantified agricultural objectives for the Project, stating only that it was expected to generate "increased agricultural production along with an improvement in agricultural income and diet." The Feasibility Report is more specific, indicating that the Project's objectives were to:

- extend the area capable of being cropped to B Aman by some 3700 ha. by reducing flood duration in the zone below 2 ft PWD;

- make B Aman cultivation secure throughout the area (about 9800 ha.) between 2 ft and 4 ft PWD, and extend the dry period sufficiently to enable a rabi crop to cultivated after Aman;

- facilitate a move from B Aman and Aus/Aman to Local T Aman in the area (about 5500 ha.) between 4 ft and 8 ft PWD.

The linkages between these objectives and the Project's expected hydrological impacts are shown in Table 2.1 in Chapter 2. In the lower zones the extension and securing of the B Aman area depended primarily on reducing the duration of flooding, while the move to T Aman in the higher areas depended more on reduced flood depth; in the highest paddy areas (6 to 8 ft PWD) T Aman was expected to need supplementary irrigation, and it was expected that facilities introduced for this purpose would also make possible the irrigation of rabi crops.

It was expected that the variety changes, together with greater input use encouraged by flood security, would raise paddy yields by about 640 kg./ha. (7 md./ac.), or 40 per cent. The combined yield increase and area extension were expected to generate about 14,800 mt of incremental paddy production. It was also expected that there would be an incremental production of some 5800 mt of non-paddy grains, pulses and oilseeds (Feasibility Report, p.A-148).

5.3 PROJECT AGRICULTURAL PERFORMANCE

5.3.1 Cropped Area

The Project was expected to bring an additional area of some 3800 ha. under cultivation. The PIE questionnaire survey did not investigate whether land currently farmed had been recently brought into cultivation, so direct measurement of Project performance in this respect is not possible. However, the pre-PIE RRA in April 1991 tentatively estimated, on the basis of a widely-dispersed series of farmer group interviews using an assessment matrix for quantification of area data, that about 5000 ha. of additional land had been brought under cultivation. This is in quite good agreement with the Project target, and it would be unrealistic to expect more precise measurement from the RRA approach. It therefore appears that the Project has fulfilled its land reclamation objective.

5.3.2 Seasonal Cropping and Intensity

The PIE survey obtained data on the area of all plots cultivated by sample households and on the crops grown on them in each season. Comparison of the results for the protected and control areas can then show the Project impact on cropping pattern. The results are summarised in Tables 5.1 to 5.3.

During the Aus season, the percentage of land under paddy crops in the protected area is about double that in the control area (Table 5.1). The intensity over all crops is about 10 per cent higher in the protected than in the control area, due to high intensities of non-paddy crops (mainly sugar cane) on the higher land in the control. The greater intensity in the protected area is very pronounced in the three lowest land levels, where the percentage of cultivable area under mixed Aus/Aman is over double that in the control area. This is an expected Project impact, since shallower flooding is required for safe harvesting of the Aus component of the Aus/Aman mixture. It is slightly surprising that Aus/Aman is almost as widely grown on very low land as on low and medium-low land, since it would be expected that the very low land would flood earlier and more deeply. However, these lands may be planted, and therefore harvested, earlier than those which are less deeply flooded.

Other Aus season crops, with the exception of sugar cane, are of negligible importance both in the project and control area. Very small percentages of area are under jute in both the protected and control areas; the RRA found that jute cultivation had decreased by 24 times in the project area compared with the pre-project period. The jute area has been mainly used for mixed Aus/Aman cultivation. Sugarcane is cultivated on nearly 15 per cent of land in the control area, compared with only about 2.5 per cent in the protected area, but the reason for this is unclear. Sugarcane is mostly a medium high land crop and is not affected severely by flooding, but this does not explain why the medium high land in the protected area grows only a tenth as much sugar cane as in the control.

In the Aus season, all the land levels are equally used in the project area but in the control area high lands are used more than the low land levels. Most of the Aus/Aman is cultivated in the low lands. This indicates a lower risk of flood in the project area.

The land use pattern in the Aman season (Table 5.2) also indicates the project's success in controlling water levels. In this season, in the Project area, the percentage of area under Local B Aman, which grows well in deep to moderately deep water in the low lying beel centres, is much less than in the control area. Additionally, about 15 per cent of cultivated land is under Local T Aman (which requires relatively shallow water) in the project area, compared with only 3 per cent in the control. Over 30 per cent of high land in the protected area is under HYV T Aman, whereas none is grown in the control area. This may be because of non-availability of supplementary irrigation. However, paddy dominates Aman season cultivation in both the areas (97 per cent of the total cropped area in the protected area as against 77 per cent in the control area).

The percentage of total land used in the project area during the Aman season is somewhat higher than in the control area, again indicating a positive project impact. Not unexpectedly, both the protected and control areas show declining intensities at the lower land levels, but level for level the intensity in the protected area is about 10 to 15 per cent higher than in the control.

Table 5.1 Distribution of Cultivable Land by Crop: Aus Season

Area	Land Level[1]	Total Land Area (ha.)	Percentage of Cultivable Area Under									
			B.Aus	T.Aus LV	T.Aus HYV	Aus/Aman Mixed	All paddy	Jute	Sugar cane	Oilseeds	Betel leaf	Total
Impacted Protected	HL	10.03	15.55	16.55	3.69	4.29	40.08	3.48	1.99	4.38		49.95
	MH	22.41	17.67	3.66	1.78	10.13	33.24		5.49	1.96		40.70
	ML	36.89	3.60	-	3.12	50.91	57.63	0.46	3.47	1.38		62.94
	LV	47.59	2.65	-		49.97	52.62		0.63			53.25
	VL	5.88				45.92	45.92					45.92
Total :	%	100.0	6.60	2.02	1.56	39.05	49.24	0.42	2.45	1.13		53.25
	ha.	122.80	8.11	2.48	1.92	47.96	60.47	0.52	3.01	1.39		65.39
Control	HL	5.08		0.14		7.48	21.48		18.50		5.31	34.40
	MH	7.57	15.32			14.13	29.46		51.52			89.30
	ML	15.13	8.46			23.79	32.25		6.54			40.91
	LL	25.34	8.29			18.07	26.36		16.42			29.83
	VL	11.66	6.77			12.09	18.87		12.09			20.07
Total :	%	100.0	8.23	0.22		17.04	25.49		14.54		0.42	42.93
	ha.	64.78	5.33	0.14		11.04	16.51		1.60		0.27	27.80

Source: PIE Household Survey

Table 5.2 Distribution of Cultivable Land by Crop: Aman Season

Area	Land Level[1]	Total Land Area (ha.)	Percentage of Cultivable Land Under							
			B.Aman LV	T.Aman LV	T.Aman HYV	B.Aus/Aman Mixed	All paddy	Sugar cane	Betel leaf	Total
Impacted	HL	10.03	5.48	41.97	32.60	4.29	84.35	1.99		86.34
	MH	22.41	8.52	59.26	12.72	10.13	90.63	5.49		96.12
	ML	36.89	22.20	3.88	1.82	50.91	78.80	3.47		82.27
	LV	47.59	15.76			49.96	65.73	0.65		66.38
	VL	5.88	24.83			45.92	19.19			70.75
Total :	%	100.0	15.97	15.40	5.53	39.05	75.96	2.46		78.42
	ha.	122.8	19.61	18.92	6.79	47.96	93.28	3.02		96.30
Control	HL	5.08	2.95			7.48	10.43	57.87	5.31	73.62
	MH	7.57	8.99	2.77		14.13	25.89	52.84		78.73
	ML	15.13	29.80	8.92	1.39	23.79	63.91	6.87		70.79
	LL	25.34	31.57	2.01	0.55	18.07	52.21	5.13		57.34
	VL	11.66	43.37			12.09	55.66	1.20		56.86
Total :	%	100.00	28.43	3.19	0.54	17.04	49.21	14.54	0.42	64.82
	ha.	64.78	18.42	2.07	0.35	11.04	31.88	9.42	0.27	41.59

Source: PIE Household Survey

Table 5.3 Distribution of Cultivable Land by Crop: Boro Season

Area	Land Level[1]	Total Land Area (ha.)	Boro LV	Boro HYV	All Paddy	Wheat	Pulse	Oil-seed	Onion & Garlic	Sugar cane	Winter vege-tables	Chilli	Betel leaf	Others	Total
Impacted	HL	10.03		9.27	9.27	2.79	24.13	12.86		2.0					51.05
	MH	22.41		6.92	6.92		5.62	1.92		7.85					22.31
	ML	36.89	3.28	5.80	9.08		2.82	5.12		3.93	0.32				21.28
	LV	47.59	6.85	2.42	9.27		0.17	0.63	0.13	0.48					10.67
	VL	5.88	7.31		7.31		0.05								12.41
Total :	%	100.0	3.99	4.70	8.69	0.23	4.15	3.18	0.05	2.96	0.10				19.36
	ha.	122.80	4.9	5.77	10.67	0.28	5.10	3.91	0.06	3.64	0.12				23.78
Control	HL	5.08					6.10	10.04		62.00		0.79	5.31	0.60	84.84
	MH	7.57				5.54	22.19	2.24	0.39	52.84					83.22
	ML	15.13	26.24	9.65	35.89		6.48	1.06	1.06	6.01	0.33				50.83
	LL	25.34	14.17	2.01	16.18		1.18	2.09		5.13					24.58
	VL	11.66	21.10		21.10					1.20					22.29
Total :	%	100.0	15.47	3.04	18.50	0.65	5.05	2.11	0.29	16.39	0.08	0.06	0.42	0.05	41.76
	ha.	64.78	10.02	1.97	11.99	0.42	3.27	1.37	0.19	9.42	0.05	0.04	0.27	0.03	27.05

Source: PIE Household Survey

The proportion of land under Boro cultivation is very low in the project area (Table 5.3). Irrigation by LLP and few privately owned STW is mostly restricted to the northern part (Kalia Upazila), where a limited amount of HYV Boro is cultivated. Boro cultivation in the control area occupies twice as much land as in the project area, but the difference is entirely due to larger areas of Local Boro on the lower lands in the control. Since Local Boro is grown on residual moisture, this may indicate that the Project's success in controlling monsoon water levels leaves insufficient moisture for the traditional dry season cropping pattern. The RRA detected a reduction over time in Local Boro cultivation in the protected area, which would support this view. Boro season cropping intensity is much higher in the control area than in the protected area, due to the importance of sugar cane. Non-paddy grains, oilseeds and pulses are of minor importance in both areas, and there is no sign of the expansion of these crops forecast in the Feasibility Report.

The total intensity of land use in both the areas over all the seasons is almost identical. The main difference is that Aman is cultivated more than non-paddy crops in the project area, indicating that the project has substantially achieved its intended impact in the monsoon season. Mixed Aus/Aman cultivation is extensive in the area as farmers can harvest Aus followed by Aman from the same land and as they do not have to wait for a long time for a single crop (Aus or Aman) harvest. The choice of mixed Aus/Aman Cultivation was probably been helped by the negligible amount of Boro cultivation in the area. Since Aus tends to be displaced by HYV Boro. Non paddy crops occupied only 11 per cent of the gross cropped land as against 37 per cent in the control area. The non -paddy crops are either rabi crops or perennial crops which need irrigation. As the project area has soil moisture stress in the dry season the non paddy crops are not grown extensively in the project area, whereas in the control area flood water maintains high soil moisture which facilitates non-paddy crop cultivation.

5.3.3 Cropping Patterns

The dominance of paddy in the cropping pattern is clear from the PIE data (Table 5.4). Paddy occupies about 89 per cent of the gross cropped area in the protected area, as against

63 per cent in the control area. This is in agreement with RRA observations, which showed a lower percentage of paddy (42 per cent of cropped area) in the project area in the pre-project period. This difference in paddy cropped area is attributable to the extensive cultivation of mixed Aus/Aman in the lower lands (whether reclaimed or made more secure) in the Project area. The improved water control in the Project has made possible better timing of the mixed Aus/Aman sowing, while retaining sufficient water for the remaining broadcast Aman after the Aus harvest.

Varietal changes within the paddy crop have been smaller than forecast by the Feasibility Report, and there has been very little movement into HYVs (Table 5.5). There appears to have been some movement from broadcast to transplanted Aman in the higher land; in the protected area Local and HYV T Aman together occupy abot 21 per cent of the land in the Aman season, compared with under 4 per cent in the control area. However, the shift to transplanted varieties has certainly not taken place throughout the higher areas, as originally expected. The reasons are not clear; drainage congestion is not likely in these relatively high areas, but soil moisture may be a constraint.

Table 5.4 Cropping Pattern
(% of Gross Cropped Area)

Crops	Impacted						Control					
	HL	MH	ML	LL	VL	All level	HL	MH	ML	LL	VL	All levels
B.Aus,LV	0.84	2.14	0.72	0.70	-	4.40	-	1.2	1.33	2.18	0.82	5.53
T.Aus,LV	0.90	0.44		-	-	1.34	0.14				-	0.14
T.Aus,HYV	0.20	0.22	0.62	-	-	1.04						
B. Aus/Aman, Mixed	0.46	2.44	20.24	25.65	2.91	51.7	0.79	2.21	7.46	9.50	2.92	22.89
B. Aman LV	0.30	1.03	4.42	4.04	0.79	10.58	0.16	0.71	4.68	8.30	5.27	19.12
T. Aman LV	2.27	7.16	0.77	-	-	10.20	-	0.22	1.40	0.53	-	2.15
T. Aman HYV	1.76	1.54	0.36	-	-	3.66	-	-	0.22	0.14	-	0.36
Boro LV			0.65	1.76	0.23	2.64	-	-	4.12	3.72	2.55	10.39
Boro HYV	0.05	0.83	1.16	0.62	-	3.11	-	-	1.51	0.53	-	2.04
All Paddy	7.23	15.80	28.94	32.77	3.93	88.67	1.09	4.35	20.72	24.90	11.96	62.62
Wheat	0.15		-			0.15	-	0.42	-	-	-	0.42
Jute	0.19		0.09	-		0.28	0.68	0.65	0.33	-	-	1.66
Pulse	1.30	0.68	0.56	0.04	0.16	2.74	0.32	1.74	1.02	0.31	-	3.39
Oilseeds	0.93	0.47	1.29	0.16		2.85	0.53	0.18	0.17	0.55	-	1.43
Onion/Garlic				0.03		0.03	-	0.03	0.17	-	-	0.20
Sugarcane	0.33	2.28	2.16	0.45		5.22	9.15	12.45	3.24	4.04	0.44	29.32
Betel leaf							0.84		-	-	-	0.84
Chilli							0.04		-		-	0.04
Summer vegetables												
Winter vetgetables	-	-	0.06		-	0.06	-	-	0.05			0.05
Others	-	-	-		-	-	0.03				-	0.03
%	10.13	19.23	33.12	33.43	4.09	100.0	12.68	19.82	25.7	29.8	12.0	100.0
ha	18.79	35.66	61.42	62.01	7.59	185.47	12.22	19.12	24.77	28.74	11.57	96.42

Source: PIE Household Survey

Single cropped land occupies only 20 per cent of the gross cropped area. Broadcast Aman is the dominant crop on the peat soil of the low-lying beel centres, whereas T Aman is a dominant crop in the higher land levels, but the percentage of gross cropped land occupied by either crop is small (8 per cent for B Aman, 5.5 per cent for T Aman). The control area shows a similar percentage of land under single crop cultivation. Here B Aman is the dominant crop, the area of Local T Aman being very low in the control area.

Table 5.5 HYV paddy concentration

Crop Season	Impacted		Control	
	% of land for paddy	% of gross cropped land	% of land for paddy	% of gross cropped land
Aus	1.17	1.04	-	-
Aman	4.13	3.66	0.57	0.36
Boro	3.51	3.11	3.24	2.04
All HYV (%)	8.81	7.81	4.50	2.41
Total land (ha.)	164.42	185.47	60.80	96.42

Source: PIE Household Survey

Within the double crop cropping pattern, B Aus followed by T Aman occupies 28 per cent of the high land, whereas mixed Aus/Aman occupies about 90 per cent of the low-lying cultivated land in the project area. In contrast to the project area, mixed Aus/Aman occupies the major portion of the cultivated area in the control area in all land levels. About 65 per cent of the gross cropped area in the project is double cropped, whereas only 43 per cent of the land in the control area is double cropped, indicating a better flood control situation in the project area.

In the project area, 15 per cent of the gross cropped land is cultivated with a sequence of pulses or oilseeds in the dry season followed by mixed Aus/Aman in the monsoon, whereas this sequence occupies 35 per cent of land in the control area.

5.3.4 Cropping Intensity

There is almost no difference in overall cropping intensity between the project area and the control area (Table 5.6), but paddy cropping intensity in the project area is 134 per cent compared with 93 per cent in the control area. The PIE data for cropping intensity show close agreement with the ESL evaluation of Kolabasukhali, which found the cropping intensity was 142 per cent.

Cropping intensity has mainly increased in the low-lying areas in the project, and this must be attributed to the Project's impacts on flood depth and duration. However, there are differences in the opposite direction on higher land, which may be due to soil moisture stress, especially during the Boro season when only 19 per cent of the total cultivable area is used for all crops in the protected area.

Table 5.6 Cropping Intensity

Land Level	Land Area				Cropping Intensity		
	Total Cultivable Land (ha.)		Total Area Cropped (ha.)		Impacted		Control PIE
	Impacted	Control	Impacted	Control	PIE	Feasibility	
HL	10.03	5.08	18.80	12.22	187.44		240.55
MH	22.41	7.57	35.66	19.54	159.12		258.12
ML	36.89	15.13	61.42	24.77	166.49		163.71
LL	47.59	25.34	62.01	28.74	130.30		113.42
VL	5.88	11.66	7.59	11.57	129.08		99.23
All levels	122.80	64.78	185.47	96.42	151.03	126.0	148.84
All Paddy	122.8	64.78	164.42	60.38	133.89		93.21

Source: PIE Household Survey
Note:

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

5.3.5 Crop Yields

The project area shows higher crop yields than the control for all the paddy crops except Local Boro and Local T Aus (Table 5.7). The factors that contribute to this change appear to be reduced flood risk and increased use of fertilizer, the latter being linked to the former. Although there has been little adoption of HYV paddy, mean paddy yield over all varieties is 1.37 mt/ha in the project area compared with 1.02 mt/ha in the control area, while mean yield of monsoon paddy (where Project impacts are assumed to be concentrated) are 1.27 and 0.8 mt/ha.. The latter represents a superiority of 0.47 mt/ha or 59 per cent. The proportional increase is considerably greater than the 40 per cent predicted by the Feasibility Report, but the overall yields and the absolute difference between them are much smaller. This may be due to effects specific to the year of survey, since both protected and control areas are known to have experienced storm damage.

Amongst the individual paddy varieties, the superior performance of T Aman in protected area is particularly noteworthy, and clearly reflects the impact of improved water control. The superiority of the B Aman and Aus/Aman which make up most of the paddy area is not so marked, but on the lowest land both performed very much better in the protected area than in the control area. Local Boro yields are lower in the protected than in the control area, and since this probably reflects moisture stress caused by the drier with-Project conditions, the reduction should be considered as a Project impact and deducted when assessing net benefits to the Project.

Weighted average paddy yield over all varieties shows a declining trend by land level in both the protected area and in the control area. The protected area yields are superior for all levels, but the trend shows that there is still considerable scope for removal of drainage congestion.

Table 5.7 Yield of Paddy by Land Level
(mt./ha.)

Paddy	Impacted						Control						
	HL	MH	ML	LL	VL	Avg yield (tons/ha.)	HL	MH	ML	LL	VL	Avg yield (tons/ha.)	Yield diff (tons/ha.)
B. Aus, LV	1.17	1.52	1.48	0.21	-	1.24	-	0.96	1.63	0.32	0.71	0.83	+0.41
T. Aus, LV	2.04	2.63	-	-	-	2.24	2.56	-	-	-	-	2.56	-.32
T. Aus, HYV	2.70	3.41	4.88	-	-	4.15	-	-	-	-	-	-	+4.15
B. Aus/Aman Mixed	0.71	1.22	0.97	0.81	0.96	0.90	1.80	0.83	0.88	0.74	0.49	0.80	+0.10
B. Aman LV	2.05	0.99	1.28	0.71	0.60	0.96	0.72	0.72	0.85	0.82	0.38	0.70	+0.26
T. Aman LV	2.63	2.26	2.26	-	-	2.37	-	2.48	1.68	0.43	-	1.45	+0.92
T. Aman HYV	3.23	3.29	3.89	-	-	3.32	-	-	0.71	1.77	-	1.15	+2.17
Monsoon paddy	2.42	2.10	1.33	0.76	0.83	1.27	1.72	0.96	1.05	0.72	0.43	0.80	+0.47
Boro LV	-	-	0.82	1.73	1.12	1.45	-	-	1.23	1.93	1.69	1.60	-0.15
Boro HYV	3.22	3.92	4.61	2.66	-	3.81	-	-	4.22	1.67	-	3.56	+0.25
All paddy	2.49	1.92	1.39	0.90	0.86	1.37	1.72	0.96	1.27	1.08	0.78	1.02	+0.35

Source: PIE Household Survey

Among the non-paddy crops, yields of rabi crops are lower in the protected area than in the control area, probably reflecting shortage of residual moisture in the protected area (Table 5.8). The exception is sugarcane, which yields almost three times more in the protected than in the control area. Sugar cane is a new crop in the protected area (RRA observation) where it has been introduced since the improvement of water control.

Table 5.8 Yield of Non-Paddy Crops by Land Level
(mt./ha.)

Crops	Protected						Control					
	HL	MH	ML	LL	VL	Avg. Yield	HL	MH	ML	LL	VI	Avg. yield
Wheat	1.05	2.49	1.83	-	-	1.05	-	1.42	-	-	-	1.42
Jute	1.16	1.00	1.62	-	-	1.07	1.36	1.83	0.40	-	-	1.35
Pulse	0.57	0.9	0.62	0.92	0.37	0.65	-	0.34	0.32	0.12	-	0.28
Oilseed	0.60	0.68	0.23	0.03	-	0.39	0.72	0.71	0.35	0.42	-	0.56
Chilli	-			-	-		3.69	-	-	-	-	3.69
Onion/Garlic	-	-		0.92	-	0.92	-	0.88	1.02	-	-	0.90
Sugarcane	10.29	17.85	14.35	23.03	-	15.82	5.04	7.0	10.43	0.56	5.74	5.70
Winter Vegetables	-			3.27	-	3.27	-	-	1.42	-	-	1.42
Betel leaf (Pon/ha)	-		-	-	-	-	22458.24	-	-	-	-	22458.24
Other	-	-	-	-	-	-	3.5	-	-	-	-	3.5

Source: PIE Household Survey

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5.3.6 Crop Production and Output

The 34 per cent change in paddy yield over all seasons (Table 5.9) and 42 percentage point change in paddy crop intensity has influenced the output change in the project area. In the project area paddy, which occupies about 89 per cent of the gross cropped area, is the most important crop, and therefore paddy production has the major impact on changes in output. The protected area, as compared to the control area, produces about 94 per cent more paddy annually (Table 5.10). This high production rate is the result of decreased flood losses and increased mixed Aus/Aman area in the low-land levels. The incremental annual paddy production is some 16500 mt (Table 5.10), comparing closely with expected annual benefit of 14800 mt in the Feasibility Report (non-irrigated scinario).

Table 5.9 Paddy Output from PIE Sample

Paddy	Protected			Control		
	Cultivated land area (ha)	Total output (mt)	Yield/ha (mt)	Cultivated land area (ha)	Total output (mt)	Yield/ha (mt)
B.Aus LV	8.11	10.06	1.24	5.33	4.42	0.83
T.Aus LV	2.48	5.55	2.24	0.14	0.36	2.56
T.Aus HYV	1.92	7.97	4.14			
B.Aus/Aman Mixed	95.92	86.52	0.90	22.08	17.65	0.80
B.Aman LV	19.61	18.82	0.96	18.42	12.89	0.70
T.Aman LV	18.92	44.84	2.37	2.07	3.00	1.45
T.Aman HYV	6.79	22.54	3.32	0.35	0.88	1.15
Monsoon paddy	153.75	195.26	1.27	48.39	38.72	0.80
Boro LV	4.90	7.10	1.45	10.02	16.03	1.60
Boro HYV	5.77	21.98	3.81	1.97	7.01	3.56
All paddy	164.42	225.38	1.37	60.38	61.76	1.02

Source: PIE Household Survey

The calculation of incremental paddy output include the effect of reduced Boro yields, which are likely to be a Project effect. Differences in between protected and control areas for non-paddy crop areas and output are smalls, except in the case of sugar cane. For sugar cane, the direction of yield and area differences are opposite, so that the net effect is a rather small negative chnage of about 8200 mt. per year.

5.3.7 Crop Production Inputs

Although HYV adoption in the protected area is insignificant, input use is higher than in the control area. Input use has increased in the protected area as crop damage from flooding decreases and as conditions become suitable for varieties which can utilise higher input rates. Yield have then increased as a result of higher input use.

The use of animal labour is higher in the protected area than in the control area, but the cost per unit is lower in the protected area. In many of the lower lands in the protected area, ploughing with draught animals is not possible in the low lying areas as the soil is very soft. Human labour replaces source of draught power for ploughing in these areas, which costs more as human labour takes more time to plough a given area. All the other costs are similar for both areas, with the exception of irrigation cost. Mechanical irrigation is used (Table 5.11) during the Boro and Aus season in the protected area. Although the amount of land irrigated was very low, the cost of mechanical irrigation in the protected area raised the weighted mean cost of production by about Tk.1000 per hectare. Mechanical irrigation may be facilitated in the project area due to flood control.

Table 5.10 Derivation of Incremental Paddy Production

		Protected Area Yield (mt/ha)	Control Area Yield (mt/ha)	Output (mt)
Net Cultivable Impacted Area (ha)	18623			
Impacted Area Cropping Intensity (%)	134			
Gross Cultivated Impacted Area (ha) (at observed intensity)	24955	1.37		34188
Control Area Cropping Intensity (%)	93			
Gross Cultivated Impacted Area (ha) (at Control Area Intensity)	17319		1.02	17665
Incrmental Paddy Production (mt.)				16523
Incremental paddy Production (%)				94

Source: PIE Household Survey

Table 5.11 Irrigated Area by Means of Irrigation

Seasons	Impacted – Protected: Total Cropped Land (ha.)	Impacted – Protected: % area irrigated – Indigenous method	Impacted – Protected: % area irrigated – Mechanical method	Control: Total Cropped Land (ha)	Control: % area irrigated by – Indigenous method	Control: % area irrigated by – Mechanical method
Aus	65.39	-	1.25	28.97	-	-
Aman	96.30	-	-	41.99	0.50	-
Boro	23.78	1.85	24.35	27.13	9.03	4.31

Source: PIE Household Survey

Fertilizer use in is similar for the same paddy varieties in the protected and control areas (Table 5.13) except in the case of B Aus and Local T Aman, where protected area farmers used much higher rates. Control area farmers used more fertilizer on Local Boro, in agreement with other evidence that this crop is better suited to control area conditions.

Farmers spend less on inputs for non-paddy crops in the impacted area than in the control area, whereas the reverse is the case for paddy (Tables 5.12, 5.14), reflecting the balance of benefits following the Project's impact on water control in the protected area.

Table 5.12 Breakdown of Production Costs: Paddy Crops

Area Type	Paddy	Seeds/ Seedlings (%)	Human Labour (%)	Animal[1] Labour (%)	Fertilizer manure (%)	Pesticide (%)	Irrigation (%)	Total (%)
Impacted Protected	B.Aus LV	9.57	57.52	26.59	5.61	0.71	0.00	7989.30
	T.Aus LV	6.97	57.70	17.19	5.63	1.76	10.75	9116.45
	T.Aus HYV	8.30	65.86	18.93	5.35	1.56	0.00	8612.38
	Aus/Aman Mixed	15.16	54.23	26.93	3.46	0.22	0.00	3656.03
	B.Aman LV	12.35	53.05	31.74	25.60	0.30	0.00	5516.20
	T.Aman LV	7.37	59.71	23.49	8.53	0.90	0.00	8731.19
	T.Aman HYV	7.67	49.57	22.12	17.69	2.95	0.00	8327.08
	Boro LV	15.23	61.95	14.66	4.42	3.74	0.00	6583.30
	Boro HYV	6.60	33.87	14.95	15.59	3.09	25.93	13229.03
	Weighted average	9.50	45.98	21.75	6.53	1.07	15.17	6838.68
Control	B.Aus LV	10.91	61.42	25.60	1.15	0.92	0.00	6190.10
	T.Aus LV	9.62	50.01	30.78	9.59	0.00	0.00	5350.08
	T.Aus HYV	-	-	-	-	-	-	-
	T.Aus/Aman Mixed	15.53	58.99	21.26	3.96	0.26	0.00	3570.05
	B.Aman LV	12.28	52.64	33.45	1.49	0.13	0.00	5031.71
	T.Aman LV	9.95	55.67	27.72	6.67	0.00	0.00	7217.65
	T.Aman HYV	5.99	69.76	9.89	14.35	0.00	0.00	11346.03
	Boro LV	14.97	56.15	16.05	7.26	2.95	2.62	7586.56
	Boro HYV	7.76	45.50	17.83	16.40	4.61	7.71	10577.70
	Weighted Average	12.22	55.88	24.20	5.11	1.31	1.26	5727.54

Source: PIE Household Survey

Note: [1]Animal labour includes labour for land preparation and bullock rental costs

5.3.8 Value of Crop Output and Net Return

The annual net output value of paddy crops, including the value of by products, in the protected area is about double that in the control area (Table 5.16). The cost and return ratio is 1:1.72 in the impacted area as against 1:1.43 in the control area, indicating greater input productivity under the more controlled hydrological conditions of the protected area. The difference in net output value per hectare is about Tk. 2500. Considering individual crops, the difference in net return is highest for T Aman (both Local and HYV), followed by Local B Aus.

5.13 Input Use Per Hectare for Paddy Crops

	Paddy	Seeds/Seedlings (Tk.)	Human Labour (Mondays)	Animal Labour (Pair days)	Fertilizer manure (Kg)	Manure (Md.)	Pesticide (Kg.)	Irrigation (Tk.)
Impacted Protected	B.Aus LV	764.6	115	33	74.7	10.4	0.52	0.0
	T.Aus LV	635.6	131	24	93.3	0.0	1.46	979.95
	T.Aus HYV	714.6	142	25	23.2	1.22	0.0	0.0
	B.Aus/Aman Mixed	554.3	49	15	22.2	3.0	0.07	0.0
	B.Aman LV	681.6	73	27	24.0	2.6	0.15	0.0
	T.Aman LV	643.5	130	32	126.4	15.5	0.71	0.0
	T.Aman HYV	638.5	103	28	255.1	14.7	2.24	0.0
	Boro LV	1002.7	102	14	51.6	0.0	2.23	0.0
	Boro HYV	872.8	112	30	373.2	0.0	3.72	3429.0
	Weighted Average	648.8	79	22	76	5.1	0.67	1037.74
Control	B.Aus LV	675.4	95	25	14.2	0.0	0.52	0.0
	T.Aus LV	514.6	67	24	102.9	0.0	0.0	0.0
	T.Aus HYV	-	-	-	-	-	-	-
	B.Aus/Aman Mixed	554.3	53	12	25.3	0.0	0.08	0.0
	B.Aman LV	617.9	66	26	15.0	0.0	0.06	0.0
	T.Aman LV	718.0	100	31	91.1	0.0	0.0	0.0
	T.Aman HYV	680.0	198	17	308.8	0.0	0.0	0.0
	Boro LV	1135.8	107	19	109.1	0.0	2.0	198.57
	Boro HYV	821.0	120	29	334.5	0.0	4.46	815.14
	Weighted Average	700.23	91	14	53	0.0	0.66	72.24

Source: PIE Household Survey

5.14 Breakdown of Production Costs: Non-Paddy Crops

Area Challenge Charecteristic	Non-Paddy Crops	Seeds/ Seedlings (%)	Human Labour (%)	Animal[1] Labour (%)	Fertilizer manure (%)	Pesticide (%)	Irrigation (%)	Total (%)
Impacted Protected	Wheat	21.0	34.6	26.2	18.2	0.0	0.0	6736.05
	Jute	4.7	56.8	34.0	4.5	0.0	0.0	7020.66
	Pulses	27.2	50.1	20.2	2.3	0.2	0.0	3337.97
	Oilseeds	4.5	51.9	36.8	6.8	2.0	0.0	4955.23
	Onion/Garlic	13.8	57.6	25.5	3.0	0.0	0.0	27137.06
	Sugarcane	34.3	48.5	11.9	3.3	2.0	0.0	14779.92
	Winter Vegetables	3.65	75.7	20.7	0.0	0.0	0.0	11569.77
Control	Wheat	12.9	49.8	34.0	3.3	0.0	0.0	7685.50
	Jute	6.4	56.7	31.7	5.2	0.0	0.0	7161.4
	Pulses	19.8	60.1	11.9	8.2	0.0	0.0	3168.36
	Oilseeds	13.3	50.6	29.1	7.0	0.0	0.0	5950.09
	Chilli	5.7	68.7	25.6	0.0	0.0	0.0	8694.40
	Onion/Garlic	21.6	56.0	16.7	5.7	0.0	0.0	17143.59
	Winter Vegetables	2.76	73.6	16.7	6.9	0.0	0.0	13780.0
	Betel leaf	27.0	31.1	32.7*	9.2	0.0	0.0	99402.97
	Sugarcane	28.0	46.3	18.8	6.2	0.7	0.0	16439.71

Source: PIE Farm Household Survey

Note : [1]Animal labour includes labours for land preperation and bullock rental cost
* Other Costs

In the case of Local T Aus and HYV Boro the control area has an advantage over the protected area. Although the area of Local B Aman is higher in the control area, the crop gives a higher return in the impacted area, indicating better monsoon flood protection.

The net return to non-paddy crops is either negative or negligible in the protected area. As their area is negligible, the net return of non-paddy crops contributes almost nothing to the total net output of the protected area.

In estimating output values in both the areas, the same local market prices have been used to ensure comparatively; in any case prices do not differ greatly between the areas. Family labour and family draft power used have been costed at market prices.

Table 5.15 Inputs Used Per Hectare: Non-paddy Crops.

Area Characteristic	Non-Paddy Crops	Seeds/ Seedlings	Human Labour	Animal Labour	Fertilizer (Kg.)	Manure (Md)	Pesticide (Kg.)	Irrigation (Tk.)
Impacted Protected	Wheat	1411.43	58	27	254.1	0.0	0.0	0.0
	Jute	329.97	100	37		15.9	0.0	0.0
	Pulses	907.52	42	10	13.3	1.0	0.07	0.0
	Oilseeds	224.79	62	28	55.1	12.5	0.0	0.0
	Onion/Garlic	3754.40	391	106	0.0	82.3	0.0	0.0
	Winter Vegetables	442.90	219	37	0.0	0.0	0.0	0.0
	Sugarcane	5074.92	204.52	18	90	0.0	2.68	0.0
Control	Wheat	988.00	109	26	47.5	0.0	0.0	0.0
	Jute	462.20	116	23	56.3	13.5	0.0	0.0
	Pulses	629.01	54	4	42.6	0.0	0.0	0.0
	Oilseeds	791.13	86	17	65.4	14.5	0.0	0.0
	Chilli	494.00	171	22	0.0	0.0	0.0	0.0
	Onion/Garlic	3712.97	274	29	111.5	79.7	0.0	0.0
	Winter Vegetables	380.00	290	23	190.0	0.0	0.0	0.0
	Betel leaf	26879.41	882	TK. 32480.5*	1664.28	0.0	0.0	0.0
	Sugarcane	4605.17	217	31	185.7	0.0	1.07	0.0

Source: PIE Household Survey

Note: * Other Costs

5.4 PROJECT TARGETS ACHIEVED

The project has achieved its expected benefits of reclaiming about 3800 hectares of land in the low-lying areas due to flood protection. The supplementary irrigation target, however, has not been achieved, and large areas in the protected area still remain fallow during the dry season due to lack of irrigation. As a result, Boro cultivation has not been extended. The shift from broadcast to transplanted varieties has been limited, even within the land levels where it was expected to occur, and there has been very little shift from local to HYV varieties. The traditional mixed Aus/Aman crop still dominates the area.

Yield of paddy crops has increased due to greater flood security in the protected area, and consequently the annual paddy output has increased by about 16000 mt. Overall cropping intensity in the protected area does not differ from that in the control area, but paddy cropping intensity has increased by 44 per cent. Diversified cropping has not increased in the protected area, as farmers are getting better and more stable returns from paddy cultivation.

Overall, the major agricultural objectives of flood control have been achieved in this project, although drainage congestion clearly remains a constraint on yield levels and adoption of transplanted varieties.

Table 5.16 Crop Production Costs, Yields and Returns
(Tk./ha.)

Crops/Cost Return	Impacted Area		Control Area
	Protected	Unprotected	
1. B. Aus, LV			0.83
A. Grain Yield (tons)	1.24		1.66
By Product (tons)	2.48		6190.10
B. Total Cost of Production (Tk.)	7989.30		7286.98
C. Gross Return (Tk.)	10886.58		1096.88
D. Net Return (Tk.)	2897.28		
2. T. Aus, LV			2.56
A. Grain Yield (tons)	2.24		5.12
By Product (tons)	4.48		5350.08
B. Total Cost of Production (Tk.)	9116.45		20355.03
C. Gross Return (Tk.)	13206.05		15004.95
D. Net Return (Tk.)	4089.60		
3. T. Aus, HYV			
A. Grain Yield (tons)	3.32		
By Product (tons)	3.32		
B. Total Cost of Production (Tk.)	8612.38		
C. Gross Return (Tk.)	22162.86		
D. Net Return (Tk.)	13550.48		
4. B. Aman, LV			
A. Grain Yield (tons)	0.96		0.70
By Product (tons)	0.96		0.70
B. Total Cost of Production (Tk.)	5516.20		5031.71
C. Gross Return (Tk.)	6658.14		4854.89
D. Net Return (Tk.)	1141.94		-176.82
5. T. Aman, LV			
A. Grain Yield (tons)	2.37		1.45
By Product (tons)	4.74		2.90
B. Total Cost of Production (Tk.)	8731.19		7217.65
C. Gross Return (Tk.)	19537.19		11953.13
D. Net Return (Tk.)	10806.00		4735.48
6. T. Aman, HYV			
A. Grain Yield (tons)	3.32		1.15
By Product (tons)	3.32		1.15
B. Total Cost of Production (Tk.)	8327.08		11346.03
C. Gross Return (Tk.)	20383.35		7060.54
D. Net Return (Tk.)	12056.0		-4285.49
7. Boro, L.			
A. Grain Yield (tons)	1.45		1.60
By Product (tons)	2.90		3.20
B. Total Cost of Production (Tk.)	6583.30		7586.56
C. Gross Return (Tk.)	7382.85		11474.59
D. Net Return (Tk.)	3815.55		3886.03
8. Boro, HYV			
A. Grain Yield (tons)	3.81		3.56
By Product (tons)	3.81		3.56
B. Total Cost of Production (Tk.)	13229.03		10577.70
C. Gross Return (Tk.)	23902.38		22333.98
D. Net Return (Tk.)	10673.35		11756.28
Weighted Average all paddy (Tk.)	4938.16		2504.22

Table 5.16 **Crop Production Costs, Yields and Returns (continued)**
(Tk./ha)

Crops/Cost Return	Impacted Area		Control Area
	Protected	Unprotected	
9. Pulses			
A. Grain Yield (tons)	0.65		0.28
By Product (tons)			
B. Total Cost of Production (Tk.)	3337.97		3168.36
C. Gross Return (Tk.)	6964.75		3000.20
D. Net Return (Tk.)	3626.78		-168.16
10. Oilseeds			
A. Grain Yield (tons)	0.39		0.56
By Product (tons)			
B. Total Cost of Production (Tk.)	4955.23		5950.09
C. Gross Return (Tk.)	4178.93		6000.40
D. Net Return (Tk.)	-776.30		50.31
11. Sugarcane			
A. Grain Yield (tons)	15.82		5.74
By Product (tons)			
B. Total Cost of Production (Tk.)	14779.92		16439.71
C. Gross Return (Tk.)	16109.82		5845.16
D. Net Return (Tk.)	1329.90		-10594.55
12. Betel leaf			
A. Grain Yield (Pon)			350.91
By Product			
B. Total Cost of Production (Tk.)			99402.97
C. Gross Return (Tk.)			449164.80
D. Net Return (Tk.)			349761.83
13. Wheat			
A. Grain Yield (tons)	1.0		1.42
By Product (tons)			
B. Total Cost of Production (Tk.)	6736.05		7685.50
C. Gross Return (Tk.)	7087.50		9585.00
D. Net Return (Tk.)	351.45		1899.50
14. Onion/Garlic			
A. Grain Yield (tons)	0.92		0.93
By Product (tons)			
B. Total Cost of Production (Tk.)	27137.06		17143.59
C. Gross Return (Tk.)	26232.03		26517.59
D. Net Return (Tk.)	-905.03		9373.57
15. Chilli			
A. Grain Yield (tons)			3.69
By Product (tons)			
B. Total Cost of Production (Tk.)			8694.40
C. Gross Return (Tk.)			35104.04
D. Net Return (Tk.)			26409.64
16. Winter Vegetables			
A. Grain Yield (tons)	3.27		1.42
By Product (tons)			
B. Total Cost of Production (Tk.)	11569.77		21413.00
C. Gross Return (Tk.)	24536.25		10654.00
D. Net Return (Tk.)	12966.48		-10758.11
17. Jute			
A. Grain Yield (tons)	1.07		1.35
By Product (tons)	2.14		2.70
B. Total Cost of Production (Tk.)	7020.66		7161.40
C. Gross Return (Tk.)	11584.46		18378.63
D. Net Return (Tk.)	4563.80		3640.04
18. Other			
A. Grain Yield (tons)			3.5
By Product (tons)			
B. Total Cost of Production (Tk.)			21413.00
C. Gross Return (Tk.)			10654.88
D. Net Return (Tk.)			-10758.11

Source: FAP - 12 PIE Household Survey

Note : Pon = 80 leaves

6 LIVESTOCK

6.1 INTRODUCTION

Livestock is an important component of the farming system in the Project area. Animals are kept primarily as a source of draught power for land preparation, and secondarily as a source of animal protein (milk, meat, eggs) and cash income to the farm households. Most of the households in the project are farm households which keep a small number of livestock as scavenging animals.

Economically cattle are the most important type of livestock in the project area. Chickens and ducks are kept by a majority of households, but goats and sheep are kept by only a few households. Buffaloes are rarely seen in the area. Among cattle, bullocks are used mainly as draught animals and cows for milking. Nevertheless, small and marginal farmers often use cows as draught animals for land preparation. During the peak ploughing season, cows are used as draught animal by all types of farm households to overcome the seasonal shortage of draught power.

The Project had no explicit objectives related to livestock development. The Feasibility Report recognised that there was a shortage of draught power and of cattle feed in the area, and that these would become worse under the project, but failed to make any concrete plans for improving the situation. It was anticipated that the project would have an impact on increasing crop production, particularly paddy production, through changing cultivable area and cropping pattern. Any increase in cropped area and cropping intensity would lead to reduction of fallow land and grazing area for livestock on one hand, and increase requirements for draught animals on the other hand. Any change in the availability of feeds would lead to changes in the cost of production of livestock and livestock products.

It is expected that any FCD/I project will have an impact on feed resources and disease occurrence, which will influence the livestock production in the area. The impacts of the Project may be expected in the following areas:

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

In this report an attempt is made to assess the impacts of the Kolabashukhali Project on livestock using the data from the RRA and PIE surveys.

6.2 DISTRIBUTION OF PIE SAMPLE HOUSEHOLDS

In total 252 sample households were selected by random sampling, of which 169 households were in the protected area and 83 were in the control area. Sample households include all categories of farm households, as well as landless households. Livestock production data were collected from the sample households by direct interview. Table 6.1 shows the distribution of the sample households by landholding category and summaries their livestock ownership status.

Table 6.1 Distribution of Livestock Ownership Among PIE Sample Households

	Protected Area	Control Area	Total Sample
Landless Households	45	27	72
Owning Bovines	3	3	6
Owning Ovines	0	1	1
Owning Poultry	3	15	18
Marginal & Small Farmers	68	33	101
Owning Bovines	48	27	75
Owning Ovines	10	2	12
Owning Poultry	67	31	98
Medium & Large Farmers	56	23	79
Owning Bovines	43	19	62
Owning Ovines	7	3	10
Owning Poultry	53	22	75
All Households	169	83	252

Source : PIE Household Survey.

6.3 IMPACT ON LIVESTOCK HOLDING

6.3.1 Change in Number of Livestock Owning Households

The impact of the project on the number of livestock owning households was analyzed by comparing the protected and control areas; the results are presented in Table 6.2. The PIE results confirm the RRA findings that economically cattle are the most important type of animal in the project area. About 56-59 per cent of households possessed cattle, but buffaloes are kept by only one per cent of the households in the protected area. There is little variation in the proportion of livestock owning households between the protected and control areas.

The results show a clear distinction between landless and farm households, but little difference between small and large farm households (Table 3.2). Only 7 per cent of the landless households in the protected area, and 11 per cent in the control area, possessed bovine animals. In contrast, about 71 per cent of marginal and small farm households and 77 per cent of medium and large farm households in the protected area possessed bovine animals compared with 82 per cent and 83 per cent in the control area. There is little difference in percentage of households owning bovines between the protected and control areas.

The PIE results indicate that goats and sheep are not economically important animals in the project area. Only 10 per cent of all households in the protected area and 7 per cent in the control area possessed goats and sheep (Table 6.2). The PIE results indicate that there was no clear relationship between the ovine holding and the landholding of the household.

Table 6.2 Percentage of Households Owning Livestock

Species	Protected Area	Control Area
Bovines	56	59
Cattle	56	59
Buffaloes	1	0
Ovines (Goats & Sheep)	10	7
Poultry	73	82
Chickens	71	76
Ducks	39	47

Source : PIE Household Survey.

Table 6.3 Percentage of Households Owning Bovines, by Farm Size.

Farm size	Protected Area	Control Area
Landless Households	7	11
Marginal & Small Farm Households[1]	71	82
Medium & Large Farm Households[2]	77	83

Source: PIE Household Survey

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

Table 6.4 Percentage of Households Owning Ovines, by Farm Size

Farm Size	Protected Area	Control Area
Landless Households	0	4
Marginal & Small Farm Households[1]	15	6
Medium & Large Farm Households[2]	13	13

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

Source : PIE Household Survey

Poultry are an important type of livestock in the area. About 73 per cent of all households in the protected area and 82 per cent in the control area possessed poultry (Table 6.2). Chickens are the predominant species of poultry in the area; only 39 per cent of households in the protected area and 47 per cent in the control area kept ducks. The difference in the percentage of poultry owning households between the protected and control areas is small and is not statistically significant. The PIE results indicate that there are fewer poultry owning households in the landless group than amongst the farm households (Table 6.5). However, there is no clear relationship between the number of poultry owning household and the size of land holding.

Table 6.5 Percentage of Households Owning Poultry, by Farm Size

Farm size	Protected Area	Control Area
Landless Households	7	56
Marginal & Small Farm Households[1]	99	94
Medium & Large Farm Households[2]	95	96

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

Source: PIE Household Survey Data.

6.3.2 Change in the Size of Livestock Holding

The Household Survey results indicate that the size of the livestock holding per household is quite small, but that most of the farm households and a small number of non-farm households both in the protected and control areas keep a few livestock as scavenging animals.

The PIE results confirm the findings of the RRA that among the livestock, bovines, particularly cattle, are the most important type of animal to the farm households because of their contribution to draught power supply. Land preparation and thereby crop production is dependent on animal draught power. The average size of bovine holding is quite small, 1.7 head/household in the protected area and 1.6 head/household in the control area (Table 6.6). In other words, there is no significant difference in bovine holding size between the protected and control areas.

The average size of bovine holding per owning household in the protected and control areas is shown in Table 6.7. The results show that the average owning household possessed 3.1 head of cattle in the protected area and 2.8 head in the control area. The RRA results indicate that the bovine population has decreased in the project area as compared to the pre-project period. Since the size of the bovine holding per household in the protected and control areas during pre-project condition is not available, it is difficult to conclude that the difference in bovine holding between the protected and control areas is due to the project. Further study would be required to estimate the long-term impact of the project on bovine holding.

Table 6.6 Number of Livestock per Household in the Protected and Control Areas.

Species	Protected	Control Area
Bovines	1.7	1.6
Cattle	1.7	1.6
Buffaloes	0	0
Ovines (Goats & Sheep)	0.2	0.1
Poultry	7.1	6.9
Chickens	5.1	4.8
Ducks	2.0	2.1

Source: PIE Household Survey

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

Species	Protected Area	Control Area
Bovines	3.1	2.8
Cattle	3.1	2.8
Buffaloes	0	0
Ovines (Goats & Sheep)	1.8	1.7
Poultry	9.7	8.5
Chickens	7.2	6.3
Ducks	5.1	4.6

Source: PIE Household Survey

The PIE results show that there is little increase in size of bovine holding per household with increasing size of landholding (Table 6.8 and 6.9) though there is a district difference between landless and farm households. The landless households possessed only 0.1 head of cattle per household or 1.7 head per owning household in the protected area, while marginal and small farm households possessed 2.2 head per household or 3.2 head per owning household and medium and large farm households had 2.5 head per household or 3.2 head per owning household. The results indicate that medium and large farm households keep relatively fewer cattle per acre, although it is to be presumed that they have more financial resources for procurement and maintenance of bovines.

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Table 6.8 Number of Bovines per Household Based on Farm Size.

Farm Size	Protected Area	Control Area
Landless households	0.1	0.2
Marginal & Small Farm Households[1]	2.2	2.3
Medium & Large Farm Households[2]	2.5	2.4

Note: [1] Households having operated land between 0.01 and 2.50 acres.
[2] Households having operated land of 2.51 acres and above.
Source: PIE Household Survey

Table 6.9 Number of Bovines per Owning Household by Farm Size.

Farm Size	Protected Area	Control Area
Landless households	1.7	1.7
Marginal & Small Farm Households[1]	3.2	2.8
Medium & Large Farm Households[2]	3.2	2.9

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

Source: PIE Household Survey

The Household Survey results on the size of ovine (goat and sheep) holdings in the protected and control areas are presented in Tables 6.6 and 6.7. The average size of ovine holding was 0.2 head per household or 1.8 head per owning household in the protected area and 0.1 head per household or 1.7 head per owning household in the control area. The small percentage of owning households and small holding size for goats and sheep indicates that they are not important species of livestock in the area. The PIE results further indicate that the size of ovine holding does not change with increasing farm size (Tables 6.10 and 6.11). Lack of high land and scarcity of green feeds may be the reason for the small ovine holding size in the area.

Table 6.10 Number of Ovines per Household by Farm Size.

Farm Size	Protected Area	Control Area
Landless households	0	0.1
Marginal & Small Farm Households[1]	0.3	0.1
Medium & Large Farm Households[2]	0.2	0.2

Note: [1] Households having operated land between 0.01 and 2.50 acres.
[2] Households having operated land of 2.51 acres and above.
Source : PIE Household Survey.

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

Farm Size	Protected Area	Control Area
Landless households	0	2.0
Marginal & Small Farm Households[1]	1.8	1.5
Medium & Large Farm Households[2]	1.7	1.7

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

Source: PIE Household Survey.

The household survey results on incidence of poultry ownership are shown in Tables 6.6 and 6.7 It can be seen from the Table that average holding size of poultry was 7.1 birds in the protected area and 6.9 birds in the control area. The number of poultry per owning household was 9.7 birds in the protected area and 8.5 birds in the control area. Chickens are the predominant species of poultry both in the protected and control area, though ducks play a minor role.

The PIE results indicate some tendency for the size of poultry holding to increase with increasing size of farm (Tables 6.12 and 6.13). Landless households had only 0.6 birds per household in the protected area and 3.8 birds in the control area. In contrast, medium and large farm households possessed 10.1 birds per household in the protected area and 10.8 birds in the control area. A similar trend in the number of poultry is apparent with the owning households. The greater number of poultry owned by medium and large farm households both in the protected and control areas may be due to greater availability of fallen grains and other poultry feeds in the homestead.

Table 6.12 Number of Poultry per Household by Farm Size.

Farm Size	Protected Area	Control Area
Landless households	0.6	3.8
Marginal & Small Farm Households[1]	8.9	6.8
Medium & Large Farm Households[2]	10.1	10.8

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

Source: PIE Household Survey

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

Farm Size	Protected Area	Control Area
Landless households	8.7	6.9
Marginal & Small Farm Households[1]	9.0	7.2
Medium & Large Farm Households[2]	10.7	11.3

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

6.4 IMPACT ON DRAUGHT POWER

6.4.1 Draught Power Requirement

It is generally anticipated that an FCD/I project would have some effects on draught power requirements in the project area. In the case of Kolabashukhali, it was expected that protection against saline water intrusion during high tide and improvement of drainage conditions would lead to change in cropping patterns, and in the cropped area in different cropping seasons, which would ultimately cause a change in the draught power requirement for land preparation in the project area.

The household survey results on area of land operated and cropped area per household are presented in Table 6.14. The PIE results indicate that the operated area per household does not vary significantly between the protected and control areas. However, the cropped area per household in different seasons varies appreciably between the protected and control areas. The proportion of cropped land in the protected area is higher in the Aus and Aman seasons, and lower in the Boro season, than in the control area, though the cropped area per household was the highest in the Aman season in both the protected and control areas. The cropping intensity was almost the same (about 151 per cent) both in the protected and control areas. The small differences in the cropped area and cropping intensity indicate that there was a very little change in draught power requirement in the protected area due to the project.

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

Operated land/HH (acres)	Protected Area	Control Area
Total operated area	1.86	1.80
Cropped Area in:		
- Aus Season	0.98	0.71
- Aman Season	1.48	1.16
- Boro Season	0.36	0.84
- All seasons	2.80	2.71

Source: PIE Household Survey

6.4.2 Change in Draught Power Availability

The most important contribution of bovine animals to the farm household economy is the supply of draught power for land preparation. As already shown in sections 6.3.1 and 6.3.2, the percentage of bovine owning households and the size of bovine holding show little variation with farm size or between protected and control areas. RRA results indicate that bullocks and bulls are the most important animals for draught power. Cows are also used for draught purpose at peak periods, but small and marginal farm households are now increasingly using cows for draught purposes as a routine measure.

Table 6.15 shows the hard composition of bovine holdings in both the protected and control areas. The number of bovine animals per household was slightly higher in the protected area than the control area. There was a slightly higher proportion of bullocks/bulls and cows to the total in the protected area than the control area, and a distinctly lower proportion of young stock.

Table 6.15 Composition of Bovine Holdings in the Protected and Control Area.

No. of Animals/HH	Protected		Control Area	
	No.	No.	No.	No.
Bullocks/Bulls/HH	0.67	39	0.58	35
Cows/HH	0.57	33	0.47	29
Calves/HH	0.46	26	0.59	36
Buffaloes/HH	0.04	2	0	0
Total Bovines/HH	1.74	100	1.64	100

Note: HH = Household
Source: PIE Household Survey

In order to compare the draught power availability per household in the protected and control areas, bovine number have been connected into draught animal units (DAU) using the following conversion factor.

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

The available DAU per household in the protected and control areas are presented in Table 6.16. The results indicate that the number of DAU per household was higher (1.03 DAU) in the protected area than the control area (0.81 DAU). Although bullocks and bulls constitute only 39 per cent of the total bovine animals per household, they contribute about 65 per cent of the total DAU, but cows, which constitute 33 per cent of the total bovine animals, contribute only 27 per cent of the total DAU in the protected area. Only 8 per cent of the total DAU came from buffaloes in the protected area. In the control area there were no buffaloes in the sample households. The results also indicate that there are more of DAU per acre of operated land (0.55 DAU/acre) in the protected area. This indicates that farmers in the protected area are in a better position in respect of DAU availability than those in the control area.

Table 6.16 Availability of Draught Animal Unit (DAU) per Household (HH) in the Protected and Control Areas.

Draught animal/HH	Protected Area	Control Area
Bullocks+Bulls/HH	0.67	0.58
Cows/HH	0.57	0.47
Buffaloes/HH	0.04	0
DAU/HH	1.03	0.81
DAU/Acre operated land	0.55	0.45

Source: PIE Household Survey

6.4.3 Draught Power Demand and Supply

Demand for draught power is dependent on the area of operated land per household and the proportion of it which is cropped in different seasons. Draught power supply, on the other hand, is dependent on the size of bovine holding per household. As shown in Table 6.14 the operated area per household varies with the cropping seasons and with farm size. The cropped area per household is highest in the Aman season both in the protected and control area. The lowest figure of cropped land per household is in the Boro season in the protected area and in the Aus season in the control area.

Average operated land area per pair of DAU in different cropping seasons for all farm households and for medium and large farm households is shown in Table 6.17. It can be seen from the Table that the average operated area per pair of DAU for medium and large farm household was higher (7.92 acres/pair DAU) in the control area than the protected area (5.68 acres/pair DAU). The cropped area per pair of DAU in Aman season and for medium and large farm households was more than two acres both in the protected and control areas. It is assumed that at best only two acres of land can be cultivated by a pair of DAU in the Aman season within the 30 days typically available. At first sight this indicates that there is an overall shortage of draught animal power in both the protected and control areas, but that the shortage is more severe for the medium and large farm households. However, it is known from RRA results that in the very soft peat soils in the reclaimed beal areas, human labour replaces draught animals. The shortage of draught animals will therefore be less severe in relation to the area actually cultivated by them.

Table 6.17 Draught Power Requirement and Supply

Land/Pair DAU (acres)	Protected Area	Control Area
DAU/HH (No.)	1.03	0.81
Operated land/Pair DAU (all households)	3.63	4.42
Operated land/Pair DAU for M&L Farm HH	5.68	7.92
Cropped land/Pair DAU in Aman Season (all households)	2.84	2.84
Cropped land/Pair DAU in Aman Season for M&L farm HH	4.43	4.67

Source: PIE Household Survey.

The time requirement for cultivation of all operated land with the available DAU by different categories of farm households in the different cropping seasons is shown in Table 6.18. The PIE results indicate that the time requirement for cultivation of operated land per household in the Aman season was more than 30 days in both the protected and control areas. This indicates that there is a shortage of draught power both in the protected and control areas, though the shortage is slightly less severe in the protected area, in line with the higher proportion of bulls/bullocks there. Shortage of draught power was more severe for the medium and large farm households, who had shortage of draught power in almost all seasons both in the protected and control areas.

Table 6.18 Time Requirement for Cultivation of Land with Available DAU, by Cropping Seasons.

Farm Household	Days required for cultivation of land/per household					
	Protected Area			Control Area		
	Aus	Aman	Boro	Aus	Aman	Boro
Marginal + Small	17	23	5	16	24	16
Medium + Large	43	66	17	44	73	55
All Type	29	43	11	26	43	31

Source: PIE Household Survey.

6.5 IMPACT ON LIVESTOCK FEEDS

It is expected that the Project would have some impact on livestock feed resources, particularly on fallow land and grazing areas, and thereby on availability of green feedstuffs. It could be anticipated that on the other hand, with the increased production of paddy, there would be a concomitant increase in availability of paddy straw and rice bran for bovines RRA results indicate that grazing has been reduced due to conversion of fallow land into crop fields. The RRA results further indicate that paddy straw production has increased in the Project area, mainly due to increased production of Aman and Aus crops. In contrast to other projects studied by FAP 12, there has been little impact on the palatability and digestibility of straw, river cultivation of HYVs there has not taken off to a significant extent.

The PIE data on bovine feeds are presented in Table 6.19. In the protected area more than 50 per cent of all households, or 90 per cent of bovine owning households, provided some green feedstuffs to the bovines, while 100 per cent of the bovine owning households provided dry roughage to their animals. A similar percentage of households in the control area fed green feedstuffs and dry roughage to their animals.

Table 6.19 Percentage of Household Fed Green and Dry Feeds to the Bovine Animals in Last 12 months (1990-91).

Areas	Type of Feeds Bought		
	Green feedstuff (% HH)	Dry feedstuff (% HH)	Concentrate feed (% HH)
Protected	51	56	50
Control	53	57	55

Source: PIE Household Survey.

Table 6.20 shows the amount of money spent per household for feeding their bovine animals in the most recent year (1990-91). The results indicate that the greatest proportion of money was spent for dry roughage both in the protected and control areas, while the smallest proportion was spend for green feedstuffs. The small amount of spending for green feedstuffs is presumably because the bulk of green fodder is from grazing or is gathered without cash cost. The total amount of money spent per household for feeding bovines was 36 per cent higher in the protected area than the control area. This higher spending for feeding bovine animals in the protected area may be due to higher financial capability of the households due to the agricultural benefits of project (see Chapter 5).

Additional expenditure in the protected area is weighted towards concentrate feeds of high nutritional value, indicating that shortage of roughages is not the major reason for increase.

Table 6.20 Amount Spent per Household for Feeding Bovine Animals in Last 12 Months (1990-91).

Areas	Type of Feeds Fed					
	Green Feed		Dry Feed		Concentrate Feed	
	Amount/HH (Tk)	Amount/ Spending HH (Tk)	Amount/HH (Tk)	Amount/ Spending HH (Tk)	Amount/ HH (Tk)	Amount/ Spending HH (Tk)
Protected	317	615	828	1489	396	782
Control	256	483	636	1123	284	509
Protected as % of Control		127		133		154

Source: PIE Household Survey.

6.6 IMPACT ON LIVESTOCK HEALTH

It is expected that the Project might have some impact on livestock health and incidence of diseases. The RRA results showed that there has been a general deterioration of cattle health over time, mainly due to shortage of nutritious feeds, seasonal fluctuation of feed supply and seasonal overwork of the animals, but it was not clear whether this was a Project impact or the result of exogenous trends, notably rising human population pressure.

The PIE results indicate that around 39 per cent of all households used veterinary facilities for treating or vaccinating their animals during the survey year (1990-91) (Table 6.21), but that there was little difference in the number of households using veterinary facilities between the protected and control areas. The amount of money spent per household and per using household for veterinary treatment was slightly higher in the control area than the protected area. The small number of households using veterinary facilities and the small amount of spending per household for treatment and vaccination of animals indicates that the farmers are not fully aware of the usefulness of veterinary facilities for protecting their animals. Overall, the project seems to have had very little impact on livestock health in the area.

Table 6.21 Percentage of Households Using Veterinary Facilities and Amount Spent for Livestock Treatment.

	Protected Area	Control Area
% HH Used Vet. Treatment	39	33
Amount Spent/HH for Treatment (Tk)	45	47
Amount Spent/Using HH for Treatment (Tk)	116	145

Source: PIE Household Survey

6.7 HOUSEHOLD INCOME FROM LIVESTOCK

The average income from sale of live animals and livestock products (excluding draught power services) is shown in Table 6.22. Sale proceeds from live animals were lower (Tk. 948/per household) in the protected area than the control area (Tk. 1551/per household). Around 84 per cent of the total sale proceeds of live animals came from cattle and 14 per cent from poultry in the protected area. Less than 3 per cent of the total sale proceeds of live animals came from goats and sheep. The much higher live animal sales in the control area cannot be a sustainable trend (assuming approximately equal reproductive rates) and are probably a short-term reflection of adversity. It is known from PIE results that both the protected and control areas suffered crop losses in the survey year, but that there were heavier in the control area.

Average sale proceeds from livestock products were 15 per cent higher in the protected area than in the control area. Milk contributed the lion's share of the sale proceeds in both areas. Eggs and cowdung were other important components of the sale proceeds in both areas. The total sale proceeds per household from livestock sources have around 15 per cent lower in the protected area than the control area. This difference may not be significant.

Table 6.22 Average Household Income from Sale Proceeds of Live Animals and Livestock Products (in Tk.).

Sources	Protected Area	Control Area
Sale Proceeds from Live Animals	948	1551
Bovine/HH	793	1368
Ovine/HH	24	19
Poultry/HH	131	164
Sale Proceeds from Livestock Products	1375	1198
Milk/HH	1010	867
Meat/HH	50	48
Eggs/HH	179	148
Others/HH	136	135
Total/HH	2323	2749

Sources: PIE Household Survey

The net income per household from livestock sources is shown in Table 6.23. Although the gross income per household was lower in the protected area than the control area by 15 per cent, the net income per household was lower in the protected area by 52 per cent, due to higher maintenance costs, especially for foods. This result indicates that livestock production under the present form of management is of limited profitability in the protected area. However, the fact that on average the bovine holdings more than cover their costs with revenue from live animal sales, milk and cowdung, means that their essential draught power services are free to the household crop economy.

Table 6.23 Net Income per Household from Livestock Sources (Taka).

Item	Protected Area	Control Area
Gross Household Income from Livestock	2,323	2,749
Cost of Feeds and Treatment/HH	1,586	1,223
Net Income/HH	737	1,526

Source: PIE Household Survey.

6.8 SUMMARY

A comparison of the status of livestock production between the protected and control areas indicates that there is little impact of the project on livestock. In the protected area the proportion of households owning bovine animals is slightly lower, but the average holding size per owning household is slightly higher, and as a result the availability of draught power per owning household is slightly higher. Nevertheless, there is an overall shortage of draught power both in the protected and control areas, and the shortage is more severe in the Aman season, and for medium and large farm households in all cropping seasons.

The project is presumed to have had a negative impact on green feedstuff availability in the protected area by reducing fallow and grazing land, but the production of dry roughage (paddy straw) and rice bran has increased with the increasing production of paddy. Spending for bovine feeds (especially concentrates) was much higher in the protected area than the control area, an indication of positive feedback of agricultural benefits into the livestock sector.

The percentage of households owning goats and sheep and average holding size was slightly higher in the protected area than in the control area. However,neither is an important species of livestock in the area. The proportion of poultry owning households was slightly lower and average holding size was slightly higher in the protected area than in the control area.

Average income from sale of live animals and livestock products was considerably lower in the protected area than the control area, and the net income per household was very substantially lower in the protected area than the control area. This is partly due to the higher cost of feeding and maintenance of cattle in the protected area, but is also due to much higher sales of live animals in the control area.

6.9 RECOMMENDATIONS

The following measures could be taken to improve livestock production in the area.

a) A programme should be undertaken to cultivate high biomass yielding forage crops such as Napier and Para grass on the slopes of the embankment, roadsides and on homestead boundaries. This would not only produce green feedstuffs but also reduce soil erosion. Para grass, which is tolerant of wet conditions, could be cultivated on the lower part of the embankment slopes and on the borrow pits.

b) Paddy straw, which is the main feedstuff for cattle in Bangladesh, is low in both digestibility and nutrient content. However, urea treatment of straw improves both nitrogen content and digestibility of straw. A large scale extension programme should be undertaken to popularize urea treatment of straw for improving cattle nutrition in the Project area.

c) A programme for introduction of urea-molasses blocks for feeding to cattle with the straw ration should be undertaken. Urea molasses blocks are a good source of energy and nitrogen for rumen micro-organisms which in fact digest fibrous feeds, while the rumen micro-organisms themselves are a good source of protein for the ruminant. Thus, feeding urea molasses blocks as supplemental feed for cattle on straw based rations will not only improve the digestibility and palatability of the straw but also improve total nutrient intake of the animals.

d) The extension programme of the Department of Livestock Services should be extended and strengthened in the area under the FCD/I Project. Provision should be made to provide routine vaccination and mass anthelmintic doses in the Project area to protect animals against prevalent infectious and parasitic diseases.

e) As a long term measure, during selection of HYV paddy consideration should be given to straw quality because straw of some HYV has higher digestibility than the other. This will help to improve straw quality along with increase in rice production.

7 FISHERIES

7.1 INTRODUCTION

The PIE Survey of KBK conformed to the approach described in the FAP 12 Methodology Report, with the major route to detection of project impacts being by comparison with a control area. In the case of KBK the selection of a control area uninfluenced by FCD works was particularly difficult, the only available area being the incomplete Bhuter Beel Project immediately east of KBK across the Chitra River (see Figure 1.2). The use of a control area so close to the Project is clearly less than satisfactory for evaluation of fisheries impacts, since even for the species which do not migrate the two areas probably constitute a single stock.

This means that comparison of impacted and control areas will not necessarily reveal the full extent of project impact. To supplement the control approach, the fisheries modules of the PIE survey also sought evidence on changes over time. The answers to these questions may provide evidence which cannot be obtained by the control approach, but caution is needed because a there are a number of trends affecting fisheries (including over-fishing, and outbreaks of ulcerative syndrome fish disease) which owe nothing to FCD projects. In addition, it should be noted that KBK is only one of a number of large FCD projects in the immediate area. Consequently, adverse trends identified are not necessarily attributable to KBK alone, but may represent the cumulative effects of many FCD interventions.

7.2 CAPTURE FISHERIES

The project documents, as in other projects studied by FAP 12, contain no information on the pre-project fisheries situation useful for subsequent project evaluation. However, from information supplied by the Fisheries Officers of Terokhada and Kalia Upazilas it is estimated that there are about 2000 fishermen in the project area and 800 in the control area. From these fishermen, 20 were interviewed in the project area and 19 in the control area to assess the project impacts on fisheries.

The average daily catch and average number of fishing days per year per fisherman are presented in Table 7.1.

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

Items	Impacted Area	Control Area
Now	1.2	1.8
Before	2.7	3.0

Source: PIE Survey

Table 7.2 Average Number of Fishing Days per Fishermen per Year

Items	Peak Period	Lean Period	Total
Impacted Area			
Now	131	98	229
Before	129	85	214
Control Area			
Now	90	119	209
Before	94	116	210

Source: PIE Survey

The project appears to have had severe adverse impacts on capture fisheries, greatly affecting the fish stock and the catches of fishermen. The decline in average daily catch is greater in the impacted area (56 per cent) than in the control area (40 per cent). This rate of decline indicates that the effect on capture fisheries in KBK is the worst of any project included in the PIE programme. The finding on decline in catches is similar to that of the pre-PIE RRA study which found that fishermen are now catching barely 25 per cent of their previous catch. The average daily catch per fisherman in the impacted area is 33 per cent less than in the control area (Table 7.1). This decrease in average catch has compelled many full time fishermen to leave their profession and they are now working as daily labourers. The average fishing days per fisherman per year show an increase over time in the impacted area, but are constant in the control area. The increase in average fishing days in the impacted area may be attributed partly to the expansion of culture fisheries, both shrimp and fish, which have provided relatively greater scope for fishing, but mainly to the reduction in daily catch, which has probably compelled fishermen to fish more days to meet their income needs.

Peak and lean fishing periods were recorded for rivers, beels, khals and pond fisheries in both the impacted and control areas. The peak and lean fishing periods do not differ significantly between the pre- and post-project periods in impacted area, but they show remarkable differences between the impacted and control areas. In the impacted area the peak period extends from July to March and the lean period from April to June, whereas in the control area the peak period is from October to March and the lean period from April to September (FAP 12 Final Report Appendix Table J.3). These differences may be associated with the types of water bodies, timing and duration of annual flood and hence availability of fish.

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

Due to the likelihood of recall problems, only the current catch quantities and values of different species were recorded during the PIE survey. It can be seen from Table 7.3 that catches of the major carps, snakeheads and 'live fish' (shing, magur and koi) are much smaller in the impacted area than in the control, which provide further evidence of the negative impact of the project. Fishermen were also asked to compare their current catches (1990/91) with pre-project catches to determine the extent of project impact. The results obtained are presented in Table 7.4.

Table 7.3 **Average Catch per Fisherman During 1990/91**
(Quantity in kg. and Value in Tk.)

Species	Impacted area		Control area	
	Quantity	Value	Quantity	Value
Major carps	18	747	38	1234
Catfish	16	454	17	540
Hilsa	4	210	8	180
Snake-heads	52	1483	142	2962
Tilapia	-	-	-	-
Minor carps	18	526	10	178
Live fish	101	4475	132	4873
Shrimp	35	1405	32	2000
Other species	130	2268	92	1405
Total capture fish	374	11570	471	13373
Pond fish (mainly carps)	44	1664	61	1487
Overall Total	418	13234	532	14860

Source: PIE Survey

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

Extent of change	Impacted	Control
Increased more than 25%	-	-
Increased up to 25%	-	1
Catch about the same	-	1
Decreased up to 25%	9	2
Decreased more than 25%	7	15
Total no. of respondents	20	19

Source: PIE Survey

Almost all the respondents from both the areas claimed that their catches have declined substantially since construction of the Project, but the proportion claiming very large declines is greater in the control area. In the impacted area 45 per cent of fisherman claim losses of up to 25 per cent and 35 per cent claim losses over 25 per cent, while in the control area only 10 per cent claim losses up to 25 per cent and about 79 per cent claim more than 25 per cent.

The changes in catch by species are shown in Table 7.5. Except for the minor carps, the reported declines of all species are heaviest in the impacted area. The only species for which any fishermen reported increased catches are the major carps and 'live fish'. The increases are concentrated in the impacted area, and probably reflect the increased development of culture fisheries due to greater security from flooding (see Section 7.3 below). The reasons given by fishermen for the reduction in catches are shown in Table 7.6.

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

Species	Area	Increased		No change	Decreased	
		25% plus	Up to 25%		Up to 25%	25% plus
Major carps	Impacted	2	-	-	1	6
	Control	-	1	-	-	6
Catfish	Impacted	-	-	-	1	8
	Control	-	-	-	2	5
Hilsa	Impacted	-	-	-	-	1
	Control	-	-	-	-	2
Life fish	Impacted	3	1	-	-	9
	Control	2	1	-	-	9
Minor carp	Impacted	-	-	-	-	6
	Control	-	-	-	2	3
Shrimp	Impacted	-	-	-	-	-
	Control	-	-	-	-	-
Other Species	Impacted	-	-	-	7	6
	Control	-	-	1	2	8

Source: PIE Survey

Table 7.6 Fishermen's Views on Causes of Fishery Decline
(Number of fishermen responding)

Cause of Impact	Impacted area	Control area
Fish access blocked by embankment	12	6
Excess use of fertilizers and pesticides	1	-
Use of current nets	2	1
Fish disease	1	4
Excess capture of immature fish	3	1
Drying of water bodies	7	4
Decrease in fishing area	3	2
Difficulty of water transport	1	-
More fishermen catching fish	4	-
Tidal water cannot enter now	1	-
God's will	-	1

Source: PIE Survey

A majority of the fishermen from both the areas claim that blockage of fish migration routes from river to beel and vice versa and drying up of water bodies are the most important project related factors for reduction in fish stock and catches. These finding support the RRA findings that the drainage of beels and blockage of fish migration routes to and from the rivers have caused a major decline in the size of fish stocks and changed their species composition both within the project area and in the surrounding rivers. The fishermen also claimed that non-project related factors such as excessive caching of fish, fish disease, use of current nets and increased numbers of fishermen are also responsible for this reduction. Due to the sharp decline in fish stocks, many fishermen have lost their livelihood or diverted their fishing to the rivers, resulting over fishing on these water bodies. The RRA also found that declining fish stocks had forced several hundred full time fishermen to concentrate their fishing on the depleted riverine fish stock.

Fishermen's income and expenditure were assessed from their responses as detailed in Table 7.7 below.

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

Items	Impacted area	Control area
Average catch (kg.) from Table 7.3	418.0	532.0
Fish kept for home consumption (kg.)	30.0	43.0
Quantity sold (kg.)	388.0	489.0
Mean value (weighted average) Tk./kg.	31.6	28.0
Gross income	12261.0	13692.0
Boat costs-upkeep and depreciation	230.0	240.0
Fishing gear repairs and replacements	810.0	1170.0
Licences, leases, other costs	500.0	430.0
Total costs	1540.0	1840.0
Net income	10721.0	11852.0

Source: PIE Survey

The costs and earnings differ between the fisherman of two areas, but the differences are not remarkable as compared to those found in other PIE studies. The relatively lower income of the fishermen in the project area, compared to the control, may be due to adverse impacts of the project on the fish stock and catches, but may also be associated with variation in the types of gear and water bodies used by the fishermen and variations in the prices of fish with location and the kinds of fish caught. The expansion of culture fisheries in the impacted area can also be regarded as one of the factors contributing to these differences.

The involvement of family members in fishing activities is outlined in Table 7.8.

It can be seen from Table 7.8 that the fishermen are involved mostly in boat and gear repairing, as in other projects studied by FAP 12 PIEs. Fishermen in KBK take part almost equally in fishing and fish trading. Their family members take part only in repairing fishing nets and other equipment, but are not involved in any way in fishing and fish trading. No fishermen or their family members take part in fish processing in project area, though a few do so in the control area; the implication is that scarcity of supply and high demand for fish mean that it can nearly all be sold fresh. However, the differences between the impacted and control areas are very small. The indications are that the involvement of fisherman and their family members in fishing activities is almost the same in the impacted and control areas.

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

Items	Impacted area	Control area
Men		
Fish catching	24	23
Boat and gear repairing	40	43
Fish processing	-	3
Fish trading	24	18
Wives and Children		
Fish catching	-	-
Boat and gear repairing	12	12
Fish processing	-	1
Fish trading	-	-
Total percentage	100	100

Source: PIE Survey

7.3 FISH FARMING

As already noted, fisheries were almost totally ignored in the planning of KBK (although there is an interesting passing reference in the Feasibility Report to the possibility of using the residual beel areas for various forms of aquaculture). Information on the number and area of ponds, their production potential, ownership and flooding status during the pre-project situation is lacking. In the present study, attempts were made to collect at least a minimum of necessary information on culture fisheries from a sample of pond owners. The data obtained are presented in Tables 7.9 - 7.15.

Table 7.9 Numbers of Ponds and Ownership Status

Items	Impacted area	Control area
No. of pond-owners interviewed	7.00	4.00
No. of ponds involved	7.00	4.00
Area of ponds owned (ha.)	0.70	0.80
Average pond size (ha.)	0.10	0.20
Single owner ponds (no.)	2.00	1.00
Jointly owned ponds (no.)	5.00	3.00
Estimated total pond area (ha.)	280.00	60.00

Source: PIE Survey

The number of pond owners interviewed in this study is small, and the results obtained should therefore be taken as indicative rather than definitive. The smaller number of pond owners interviewed in the control area compared to the impacted area may be due to the existence of a smaller number of ponds in that area and the increased number of culture ponds in the impacted area as a result of protection from annual flooding after project implementation.

The average pond size in the impacted area is 0.1 ha, while that in the control area is 0.2 ha. The majority of ponds are in joint ownership ponds in both the impacted and control areas. This pattern of ownership is one of the most important bottle-necks for the development of culture fisheries.

The reasons for pond excavation, and the pattern of present utilization, are shown in Table 7.10.

In the impacted area the majority of the ponds were excavated to provide earth for homestead mound construction, which agrees with the findings of earlier studies. About 43 per cent of ponds in the impacted area and 50 per cent in the control area were constructed specifically for fish culture (Table 7.10). Construction of several new ponds in the flood protected areas of the project was also reported by the pre-PIE RRA.

Most of the ponds are used for both fish culture and household purposes in both the impacted and control areas. Only two ponds, both in the impacted area, are used only for fish culture. This may be associated with the greater protection of ponds from flood risks in the project area. This is supported by the finding of the RRA that the protection of ponds from annual flooding by the project has encouraged the pond owners to restock quality fish seeds. From the hygienic point of view the pattern of using ponds for more than one purpose, especially for household purposes, is a major problem in introducing intensive fish culture as it causes deterioration of water quality.

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

Items	Impacted area	Control area
Ponds excavated		
- for fish culture	3	2
- for house construction	4	-
- for other purpose	-	2
Pond utilization		
- for fish culture only	2	-
- also for household use	4	4
- also for livestock	1	1
- also for irrigation	-	-
Total no. of respondents	7	4

Source: PIE Survey

The vulnerability of ponds to being overtopped by the flood water has been ascertained from the responses of pond owners as shown in Table 7.11.

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

Items	Impacted area	Control area
Ponds subject to flooding before	2	2
Ponds still subject to flooding	-	-
Total respondents	7	4

Source: PIE Survey

Table 7.7 indicates that the ponds which were previously vulnerable to flooding are no longer so. As noted in Section 7.1, the control area selected for the PIE was in the process of being embanked, and while the embankment had not been closed at the time of survey, it appears that the area was already benefitting from some flood protection. The flood situation in the control area will improve further when the embankment is completed.

The average productivity of fish ponds in the project and control areas was ascertained and the results so far obtained are shown in Table 7.12

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

Items	Impacted area	Control area
Carps	721	934
Catfish	-	-
Tilapia	174	-
Shrimp	110	-
Other species	-	351
Total	1005	1285

??

Source: PIE Survey

Though culture fisheries are expanding within the project area due to the protection it provides from annual flooding, the average yield is still about 30 per cent less than in the control. This may be because some of the impacted area ponds are used for shrimp (see Table 7.12) with rather low yields compared with fish culture. This finding agrees with the RRA finding that flood protection has encouraged pond owners to re-stock their ponds with quality fish fingerlings and many of the newly constructed ponds are now being used for carp farming as well as for fresh water shrimp culture.

The average production per hectare is less than current national average (around 1400 kg./ha). However, the existing level of fish production can be increased by introducing relatively more intensive fish culture in the ponds which are still under flood risk due to rain water congestion. For these purposes the flood vulnerable ponds need to be protected from flooding by providing proper drainage facilities.

As a result of the development of shrimp culture, there exists a conflict of interest over sluice operation between the shrimp farmers and rice cultivators due to absence of integrated flood control and fisheries planning.

Opinions regarding the effectiveness of the DOF extension service are presented in Table 7.13.

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

Items	Impacted area	Control area
Extension effort has improved	5	1
Remains about the same	2	2
Extension is worse now	-	-
Total respondents	7	4

Source: PIE Survey

The extension service of DOF appears to have improved since the pre-project period. About 71 per cent of pond owners reported an increase in extension activity, whilst about 29 per cent considered it to be the same as before. This is really a good sign that has promise of fisheries development in future. However, the extension activities appear to have improved very little in control area, where only 1 out of 4 pond owners reported an increase.

The opinions of the pond owners about the trends in farm fish production (Table 7.14) also support the above findings.

Table 7.14 Trends in Farmed Fish Production
(No. of respondents)

Extent of change	Impacted area	Control area
Increased more than 25%	4	1
Increased up to 25%	1	-
Not changed	1	1
Decreased up to 25%	-	1
Decreased more than 25%	-	-
Total respondents	7	4

Source: PIE Survey

Table 7.14 shows that pond fish production has increased significantly within the project area. About 57 per cent of pond owners in the impacted area claimed more than 25 per cent increase in pond fish production, whilst none of them claimed a decrease, but in the control area the level of pond fish production appears to be the same as before. This may be associated with the effective protection of the project area from river flooding and tidal saline water intrusion which has provided better scope for expansion and development of shrimp and fish culture. The pond owners also reported that the higher fish price, increased demand for fish and availability of good fish seeds are the principal causes of the general trend towards greater productivity. The improved extension activity (Table 7.14) may also have played a significant role in increased pond fish production.

The profitability of pond fish culture appears to be on the increase because of increased demand for fish and rising prices, and because of improved technology and better yields. The situation in the KBK area is outlined in Table 7.15.

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

Items	Impacted area	Control area
No. of respondents	7.0	4.0
Average sales income	47.1	37.2
Average costs for stocking, feeding and harvesting ponds	15.0	9.0
Average net income	32.1	28.2

Source: PIE Survey

Although the fish production per hectare in the impacted area is far less than that in the control (Table 7.12) the income per hectare is significantly higher in the impacted area (Table 7.17). This can be attributed to the exceptionally high prices of the quality shrimp (Tk. 286/kg.) produced in the impacted area. The average cost of production per hectare in the impacted area is about 66 per cent higher than in the control. This difference may be associated with the protection of ponds from flooding by the project which creates an incentive to pond owners to invest more money for both fish and shrimp culture. The pond owners in control area could not do so as their ponds are still in flood risk. All these findings indicate that the project has moderately benefited the pond owners, and that they could derive more benefits from the project if they were provided with technical know-how through effective extension services by DOF and NGOs and with access to credit. However, the lion's share of these benefits accrues to the well-to-do farmers rather than the capture fishermen adversely affected by the Project.

7.4 FISH MARKETING

The number of traders selected for PIE study is small compared to the total number of traders per market (FAP 12 Final Reports Appendix Table J.27). Only 3 traders from the project area and 2 traders from the control area were selected purposively for interview (Table 7.16). Obviously, they cannot be considered a representative sample, and therefore the results of this study should be regarded as indicative rather than definitive. Since there is hardly any information about fish traders, there is clearly a need in future for a more detailed study with a larger sample.

The fish traders, by virtue of their profession, are well informed about the seasonal changes and long term trends in fish production. Therefore, the views of the traders on the nature and causes of changes on fish production and prices have been considered important for confirming the statements made by fishermen and pond owners. The traders reported that their number has increased by about 140 per cent in the impacted area and decreased by about 3.5 per cent in the control area since project implementation (FAP 12 Final Report Appendix Table J.27). This increase in number of traders in the project area may be attributable to the reduction in fish stocks and fishermen's catches which compels many fishermen to leave their profession or to take up other part time work, including fish trading.

As a result of the increase in number of traders and decrease in fish stocks, the quantity of fish handled per trader has decreased by about 13 per cent in impacted and 12 per cent in control areas since the pre-project period (FAP 12 Final Report Appendix Table J.29). However, these differences are far smaller than those in other PIE projects. This may be due to the closeness of this project to the sea, which allows many traders to obtain their fish supply from the estuarine fisheries which are not directly affected by FCD projects.

Changes in abundance of various fish species in the project and control areas reported by the traders are presented in Table 7.16. From the table it can be seen that most traders reported a decline in the major carps, and some reported a reduction in other important species. These findings agree with the reports of fishermen about decreases in stocks and yields of commercially important species. In the control area both traders interviewed reported a reduction in boal/pabda, while in contrast only one out of three in the impacted area did so. Some traders also reported an increase in 'live fish' and tilapia, which might be due to re-stocking of these fish by pond owners. However, the traders' opinion about the decline of shrimp in their trade is in contrast to the statements of pond owners and fishermen. This may be due to the sources of supply of shrimp handled by the traders. The shrimp price reported by the traders is very low (Tk. 25-40/kg.) as compared to shrimp price reported by the pond owners (Tk. 288/kg.). These findings clearly indicate that the traders do not receive any supply of shrimp from cultured sources, and whatever quantities they do handle are mostly from capture fisheries which are vulnerable to change due to FCD projects.

Most of the traders from both the areas considered that the blockage of fish migration routes by the FCD structures, excessive catching of juvenile fish and use of illegal nets were the main causes for the decline of fish production.

As in other PIE studies, only current (1990/91) price levels of the different species of fish were recorded from the traders (FAP 12 Final Reports Appendix Table J.33). The buying and selling prices of fishes are almost the same in both the areas, indicating the existence of more or less similar demand and supply for fish over the region. This is probably due to the location of the control area adjacent to the project.

Table 7.16 **Changes in Abundance of Fish Species/Groups**
(No. of traders reporting)

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

Source: PIE Survey

7.5 CONCLUSION

The Kolabashukhali Project has had a severe impacts on capture fisheries, resulting in sharp reduction of fish stock in beels, flood plains and rivers, and thereby in the catches of fishermen. This decline of fish catches has forced a good number of fishermen to leave their fishing profession or to adopt other professions on a part time basis, or to divert their fishing in rivers causing overfishing on these depleted water bodies.

Though the project has created opportunities for expansion of culture fisheries by protecting the ponds from river flooding and tidal saline water intrusion, the production obtained at present is far less than the losses due to the project. These are estimated to be about 283-417 mt. (Table 7.17), which may be compared with the RRA estimate of about 525 mt.

The lion's share of the benefits generated by the project out of culture fisheries accrues to well to do farmers rather than displaced and adversely affected fishermen and poor and landless farmers.

At this stage it is neither possible to correct the negative impacts of the project, nor to return the water bodies to their former condition. However, some measures could be undertaken to mitigate the losses to a some extent. This can be done by:

i. bringing all the ponds under improved shrimp and fish culture through intensive extension activities by DOF and other NGO's. For this purposes the ponds which are still under flood risks are to be protected by strengthening the embankment and providing better drainage facilities;

ii. undertaking re-stocking programme in the perennial and seasonal water bodies with quality fish seeds;

iii. providing and ensuring necessary supports, advice and credit facilities to the genuine fishermen/or fishermen groups/or pond owners;

iv. implementing New Fisheries Management Policy for transferring the leasehold rights and fishing rights to bona fide fishermen and fishermen groups;

v. resolving the existing conflict of interest over sluice operation between the shrimp farmers and paddy farmers without delay.

The overall estimated outcome of the project in terms of fish production losses and gains is illustrated in Table 7.17.

Table 7.17 Kolabashukhali - Fishery Losses and Gains

1. Area Data	
Total area	25466 ha. (18623 ha. net)
Estimated flood land was	6000 ha.
Area of flood land now drained	2000 ha. to 5000 ha.
Area of remaining flood land	4000 ha. to 1000 ha.
Area of beels, was about 600 ha., but now only about 20 ha., i.e. loss	250 ha. - 580 ha.
Area of beels remaining	350 ha. to 20 ha.
Area of internal khals, etc. no data but estimated at 200 ha. No longer fishable as tidal streams but same used for culture	200 ha. to 200 ha.
Area of external rivers, shared 50:50 with neighbouring areas $\frac{86\,km. \times 200\,m}{2}$	860 ha. to 860 ha.
2. Fishery Losses	
a) Floodplain fully drained @ 37 kg./ha.	74 mt. to 185 mt.
b) Floodplain still flooded @ 20 kg./ha.	80 mt. to 20 mt.
c) Perennial beels drained @ 400 kg./ha.	100 mt. to 232 mt.
d) Beel areas remaining @ 150 kg./ha.	52 mt. to 3 mt.
e) Internal khals @ 15 kg./ha.	3 mt. to 3 mt.
f) External rivers (shared) @ 15 kg./ha.	13 mt. to 13 mt.
	322 mt. to 456 mt.
3. Culture Fishery Gains	
Say 10% of the project area i.e. 28 ha. are rehabilitated/new ponds @ 1400 kg./ha.	39 mt. to 39 mt.
4. Net Loss	
Low	High
283 mt.	417 mt.
(RRA estimated loss is about 525 mt.)	

Source: Consultants' estimates

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8 IMPACT ON NON-FARM ECONOMIC ACTIVITIES

8.1 INTRODUCTION

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

Non-farm activities are considered by FAP 12 to be essentially the small rural industrial, trading and transport activities. In dealing with such activities during PIE case studies, FAP 12 did not consider activities under fishing, livestock and forestry - the subsectors which fall in agriculture in the broader sense of the term. FAP 12 did, however, included in its sample trading activities (e.g. dealing in rice and agricultural inputs), shop keeping and transport business (e.g. rickshaw, rickshaw van, boat). During the RRAs first hand information was gained about the trends of change, through direct observation and interviews with informed sources, while during the PIEs short case studies were conducted in each of the PIE areas in order to substantiate the findings obtained during the RRAs and to provide further insights into aspects of change.

During the case studies the key aspects investigated were, among others, level (number of units) of activities, seasonality of operation, employment (annual person days worked), production, income and demand. Given that FAP 12 identified a wide range (more than 60) of non-farm activities by type, selection of the limited number of sample respondents posed problems. However, respondents were purposively selected from all the major activities in each area and thus the sample is believed to be representative of the non-farm economy as a whole.

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

The present set of case studies on Kolabashukhali was conducted in both the impacted and the control areas. In all, FAP 12 interviewed 31 enterprises, of which 20 were in the impacted area and 11 in the control area. Because of the purposive nature of sampling, statistical analyses and tests have not been conducted. Table 8.1 shows the distribution of sample enterprises by type and by age. It should be mentioned that relatively long-established enterprises were selected in order to obtain data on the situation during the pre-project period and thereby enable comparison with the post-project situation. As can be seen from the table, most of the enterprises were established before the project was implemented. The average age of the enterprises is about 15 years for the impacted area and 10 years for the control area. The table reveals considerable age variation among the enterprises. On the average, the enterprises of pottery, wood and bamboo works, cobbler, blacksmithing and goldsmithing are relatively older than the other types.

Table 8.1 Sample Enterprises by Type and by Age

Activities	No. of units established							
	Impacted				Control			
	Before	After	Total	Av. age	Before	After	Total	Av. age
Rice milling	1	-	1	14	-	1	1	1
Wood, Cane & bamboo works	1	-	1	25	2	-	2	20
Saw mill	-	1	1	3	-	-	-	-
Gur making	-	3	3	2	1	1	2	16
Pottery	2	-	2	63	-	-	-	-
Cobbler	1	-	1	23	-	-	-	-
Blacksmithing	1	-	1	18	-	-	-	-
Goldsmithing	1	-	1	25	-	-	-	-
Tailoring	1	1	2	9	-	-	-	-
Carpentry	1	-	1	23	-	-	-	-
Rickshaw repairing	1	-	1	12	1		1	5
Stationary/Grocery	-	1	1	1	1	-	1	11
Rice trading	2	1	3	10	-	1	1	5
Rickshaw/Van transport	-	-	-	-	-	2	2	4
Boatmen	-	1	1	4	1	-	1	10
All	12	8	20	15	6	5	11	10

Source : PIE Case Studies.

8.2 OVERALL PROJECT IMPACT

Based on the findings of the RRA, and on the case studies during the PIE, an attempt has been made to scale the degree of impact of the project on the various non-farm 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) the Kolabashukhali 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	- 0	Rice Trading	- +1
Furniture and carpentry	- +1	Rickshaw/Van	- +1
Blacksmithing	- 0	Water transport	- -2
Light engineering workshop	- +1	Earth work	- +1

Overall impact - +5

Thus, the Kolabashukhali Project is assessed as having made a minor positive impact on non-farm activities.

8.3 LEVEL OF ACTIVITIES

The Kolabashukhali Project encompasses areas which are in close proximity to Khulna town. As in other study areas, the project area generally supports a variety of non-farm activities based mainly on local resources and skills. The important activities include, among others, rice milling, wood and bamboo products, pottery, blacksmithing, goldsmithing, agricultural input marketing, transport and earthwork.

Apart from the RRA and case study findings, Table 8.2, based on the community survey conducted during the PIE, gives some additional information on the growth of a few selected non-farm activities. As can be seen from the table, the relative increase in the number of rice mills and agricultural input traders has been higher in the impacted area, compared to the control area. Although there has been increased use of mechanised irrigation and cultivation, there has been no growth in engineering workshops in the project areas. Such workshops, catering spares have not increased in the control areas either. Understandably, however, oil press units have shown a decline in the project areas, as against considerable growth in the control areas.

Table 8.2 : Growth of Selected Non-farm Activities

Activities	No. of units					
	Impacted (19 Mouzas)			Control (9 Mouzas)		
	Before	After	Change %	Before	After	Change %
Rice Mill	4	15	+275	8	22	+175
Oil Press	2	1	-100	3	5	+67
Saw Mill	1	1	Nil	1	1	Nil
Light Engg. Workshop	1	1	Nil	1	1	Nil
Ag. Input marketing	1	5	+400	6	10	+67

Source : PIE Community Survey.

8.3.1 Rice and Oil Milling

Following intensification of paddy production large mechanised rice milling in the project area has increased many-fold. Small husking mills run on a part time basis and in the off-seasons, however, have not registered significant increases since these small hullers are usually powered by STW engines, the availability of which is correlated with the use of minor irrigation, and there is little irrigation in the project area. With the growth of rice mills, however, the traditional method of rice husking by dheky has largely declined. As in most other FCD/I projects, the project areas have shown a decline in oil presses, especially the manually operated units, presumably because of the general decline in oilseed production in the project area. Oil seeds tend to be replaced by HYV Boro paddy, but the lack of irrigation means that there is little Boro and what there is, is irrigated by non-Project methods.

8.3.2 Output and Input Trading

Like rice milling, trading in general and rice trading in particular have increased. However, the number of 'Kutials' engaged in processing of rice appears not to have increased considerably. With the increased use of agricultural inputs such as fertilizer, seeds, pesticides, trading activities in such items have apparently increased in the project area.

8.3.3 Agricultural Tools and Implements

The activity of producing agricultural tools and implements, made of wood and bamboo, in the form of containers, winnowers, hoes, yokes, and ploughs, appears to have shown a very modest growth. Unlike in many other FCD/I projects, however, the activity of boat making in this project area has experienced a slight increase, presumably because of recent popular use of low cost engines (mostly STW) with traditional country boats, which are found plying in the rivers which form the boundaries of the project area. It is difficult, however, to associate growth in STW engines with FCD/I Projects since these are mainly used for irrigation, especially in the dry season. Paradoxically, the increased intensity and geographical expansion of cultivation has apparently not increased the demand for agricultural tools and implements produced by blacksmiths. The number of engineering workshops also appears not to have increased in the project area, perhaps because of the close proximity of Khulna town which already has a heavy concentration of light engineering establishments.

8.3.4 Transportation

The embankment and the access road constructed under the Project have permitted an improvement in communications within the Project, bringing consequent social and economic benefits. The area still suffers, however, from lack of vehicle access in the southern half, and of a vehicle ferry to Khulna. In fact, the internal road networks have not yet developed much. The land transport benefits are also offset to some extent by a substantial decline in boat transport and the number of boatmen.

8.4 SEASONALITY OF PRODUCTION

Tables 8.3 and 8.4 show the distribution of enterprises by the seasonal duration of their activities, for impacted and control areas respectively. It can be seen from the tables that 9 out of 14 enterprise types (64 per cent) in the impacted areas, and 4 out of 8 enterprise types (50 per cent) in the control areas are run year round. The remaining 36 per cent in the impacted areas are run for a period of between 3 and 9 months; and 50 per cent in the control areas are run for a period between 2 and 7 months. It can also be seen from the tables that almost none of the enterprises, either in the impacted or control area, has shown any change in their duration of activity compared to the pre-project period. Rice trading in the impacted areas and rickshaw repairing in the control areas are the only exceptions, showing some increase in the present duration, compared to in the pre-project period.

Table 8.3 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	8.0	8.0	12.0	12.0
Wood, Cane & bamboo works	7.0	7.0	5.0	5.0	12.0	12.0
Saw mill	NA	2.0	NA	10.0	NA	12.0
Gur making	NA	2.7	NA	0.3	NA	3.0
Pottery	6.0	3.5	3.0	5.5	9.0	9.0
Cobbler	5.0	5.0	7.0	7.0	12.0	12.0
Blacksmithing	4.0	4.0	4.0	4.0	8.0	8.0
Goldsmithing	6.0	6.0	6.0	6.0	12.0	12.0
Tailoring	3.0	4.5	9.0	7.5	12.0	12.0
Carpentry	2.0	2.0	6.0	6.0	8.0	8.0
Rickshaw repairing	2.0	2.0	2.0	2.0	4.0	4.0
Stationary/Grocery	NA	5.0	NA	7.0	NA	12.0
Rice trading	4.0	4.7	4.0	7.3	8.0	12.0
Rickshaw/Van transport					-	
Boatmen	NA	3.0	NA	9.0	NA	12.0

NA - Not applicable, for those units established after the Project

Source : PIE Case Studies.

Table 8.4 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	NA	5.0	NA	2.0	NA	7.0
Wood, Cane & bamboo works	5.5	5.5	6.5	6.5	12.0	12.0
Saw mill	-	-	-	-	-	-
Gur making	NA	2.0	NA	2.0	4.0	4.0
Pottery	-	-	-	-	-	-
Cobbler	-	-	-	-	-	-
Blacksmithing	-	-	-	-	-	-
Goldsmithing	-	-	-	-	-	-
Tailoring	-	-	-	-	-	-
Carpentry	-	-	-	-	-	-
Rickshaw repairing	2.0	8.0	3.0	4.0	5.0	12.0
Stationary/Grocery	4.0	4.0	0.0	0.0	4.0	4.0
Rice trading	NA	2.0	NA	0.0	NA	2.0
Rickshaw/Van transport	NA	5.5	NA	6.5	NA	12.0
Boatmen	12.0	12.0	0.0	0.0	12.0	12.0

Source : PIE Case Studies

8.5 EMPLOYMENT

Growth in the number of rice mills has given rise to employment opportunities in the impacted areas. However, the employment in small rice hullers, operated with STW engines, is not fully attributable to the project. Additionally, employment in rice mills has been to some extent, offset by displacement of some female labour previously employed in traditional methods of rice husking. The activity of rice trading, however, has largely been able to support employment of, in particular, these displaced and distressed women through rice processing. The increased intensity of cultivation and growth in rice mills and rice trading have linkages with agricultural input supply, which has eventually created some non-farm employment opportunities. The improved communication net work has facilitated marketing of crops, vegetables and other merchandise and thereby created part-time and full-time employment in small scale trading and low-cost road transport. Construction of embankments and maintenance thereof has helped create short term non-farm employment opportunities in the form of earthworks.

As regards employment in terms of working days, Tables 8.5 and 8.6 show that 6 out of 14 (i.e 43 per cent) of enterprise types in the impacted areas are presently run for 300 days or more a year. The corresponding number for the control areas is 2 out of 8 (i.e. 25 per cent). A comparison between pre and post-project period shows that very few of the enterprises has shown any difference in the number of working days; in the impacted areas, however, there has been some increase in the case of pottery (+40 per cent) and rickshaw repairing (+84 per cent), and some decline in the case of tailoring. In the control areas, rickshaw repairing is the only type, among the comparing enterprises, showing considerable increase (+152 per cent) in working days compared to before the project. Information on road transport and boatmen in the impacted area is not available, but the working days for boatmen in the control areas have not experienced any change.

From the information presented in Tables 8.7 and 8.8, it is evident that the enterprises by and large are family based. Nevertheless, in the impacted area the incidence of hired workers is quite high, as against almost none in the control area. The incidence of hired workers, particularly for rice mills, saw mills, gur making and boatmen in the impacted area is higher than in other types of enterprise. As regards the number of person days employed in various activities, the tables reveal that compared to the control area, most of the enterprises in the impacted area employ more person days; the only exceptions are for boatmen and rickshaw repairing enterprises.

Table 8.5 Working Days of Activities by Season - Impacted Area

Activities	Days of operation during						
	Peak Period		Lean Period		Year round		Change(%)
	Before	After	Before	After	Before	After	
Rice milling	120	120	240	240	360	360	Nil
Cane & bamboo works	210	210	150	150	360	360	Nil
Saw mill	NA	40	NA	100	NA	140	-
Gur making	NA	70	NA	5	NA	75	-
Pottery	134	79	62	117	196	275	+40
Cobbler	150	150	210	210	360	360	Nil
Blacksmithing	120	120	80	80	200	200	Nil
Goldsmithing	156	156	156	156	312	312	Nil
Tailoring	90	90	270	165	360	255	-29
Carpentry	40	40	60	60	100	100	Nil
Rickshaw repairing	30	52	20	40	50	92	+84
Stationary/Grocery	NA	150	NA	175	NA	325	-
Rice trading	160	160	140	140	300	300	Nil
Rickshaw/Van transport	-	-	-	-	-	-	-
Boatmen	NA	60	NA	90	NA	150	-

Source : PIE Case Studies.

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

Activities	Days of operation during						
	Peak Period		Lean Period		Year round		Change (%)
	Before	After	Before	After	Before	After	
Rice milling	NA	150	NA	30	-	180	-
Cane & bamboo works	165	165	130	130	295	295	Nil
Saw mill	-	-	-	-	-	-	-
Gur making	NA	60	NA	40	-	100	-
Pottery	-	-	-	-	-	-	-
Cobbler	-	-	-	-	-	-	-
Blacksmithing	-	-	-	-	-	-	-
Goldsmithing	-	-	-	-	-	-	-
Tailoring	-	-	-	-	-	-	-
Carpentry	-	-	-	-	-	-	-
Rickshaw repairing	60	240	75	100	135	340	+152
Stationary/Grocery	100	100	0	0	100	100	Nil
Rice trading	NA	60	NA	0	NA	60	-
Rickshaw/Van transport	NA	115	NA	140	NA	255	-
Boatmen	348	348	0	0	348	348	Nil

Source : PIE Case Studies.

Table 8.7 Number of Workers and Annual Person-Days of Employment - Impacted Area

Activities	Average employment			Annual person days employed		
	Family	Hired	Total	Family	Hired	Total
Rice milling	1.0	12.0	13.0	360	4320	4680
Cane & bamboo works	1.0	2.0	3.0	360	720	1080
Saw mill	2.0	4.0	6.0	280	560	840
Gur making	1.3	2.3	3.6	98	173	271
Pottery	2.5	1.0	3.5	688	275	963
Cobbler	2.0	-	2.0	720	-	720
Blacksmithing	1.0	1.0	2.0	300	300	600
Goldsmithing	1.0	-	1.0	312	-	312
Tailoring	1.0	0.5	1.5	255	128	383
Carpentry	1.0	-	1.0	100	-	100
Rickshaw repairing	1.0	-	1.0	92	-	92
Stationary/Grocery	1.0	-	1.0	325	-	325
Rice trading	1.7	-	1.7	510	-	510
Rickshaw/Van transport						
Boatmen	1.0	3.0	4.0	150	450	600

Source : PIE Case Studies.

Table 8.8 Number of Workers and Annual Person-Days of Employment - Control Area

Activities	Average employment			Annual person days employed		
	Family	Hired	Total	Family	Hired	Total
Rice milling	1.0	-	1.0	180	-	180
Cane & bamboo works	2.0	-	2.0	590	-	590
Saw mill	-	-	-	-	-	-
Gur making	2.0	0.5	2.5	200	50	250
Pottery	-	-	-	-	-	-
Cobbler	-	-	-	-	-	-
Blacksmithing	-	-	-	-	-	-
Goldsmithing	-	-	-	-	-	-
Tailoring	-	-	-	-	-	-
Carpentry	-	-	-	-	-	-
Rickshaw repairing	1.0	1.0	2.0	255	255	510
Stationary/Grocery	1.0	-	1.0	100	-	100
Rice trading	1.0	-	1.0	60	-	60
Rickshaw/Van transport	1.0	-	1.0	115	-	115
Boatmen	2.0	-	2.0	696	-	696

Source : PIE Case Studies

8.6 PRODUCTION, INCOME AND DEMAND

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

The percentage of enterprises reporting "increase", "decrease" or "same" is presented in Table 8.9. The resultant changes (positive or negative) in production and income having been weighted by size of enterprise are presented in the last column of the table.

As can be seen from the table, a higher proportion of the enterprises in the control area reported increase in production, family income and demand for products; about 88 per cent of the enterprises in the control area reported increase in production, 90 per cent reported increase in their family income, and 88 per cent reported increase in demand for their products. In the impacted area about 62 per cent reported increase in production, 54 per cent reporting increase in income, and 69 per cent reporting increase in demand for products. Also, there has been marked change in the actual overall production of all types of enterprises taken together. Paradoxically, there has been an 18 per cent increase in the impacted areas as against 13 per cent increase in the control areas. As regards family income, however, the enterprises in the impacted areas have shown an increase by only 0.5 per cent as against an increase by 8 per cent in the control areas. Contrary to the change in production, demand for products again has been higher in the control areas than in the impacted areas.

Table 8.9 Changes in Production, Family Income and Demand for Products
(Compared to Pre-project Period)

Item	Area	% of enterprises reporting			Actual change (%)
		Increase	Decrease	Same	
Production	Impacted	61.5	23.1	15.4	+18.1
	Control	87.5	12.5	-	+12.6
Family Income	Impacted	53.8	23.1	23.1	+0.5
	Control	89.9	11.1	-	+7.7
Demand for Products	Impacted	69.2	30.8	-	+12.6
	Control	87.5	12.5	-	+27.0

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

Source : PIE Case Studies

Table 8.10 presents information on present annual income per enterprise from various non-farm activities. Following that the enterprises under study vary widely in capital, scale of operation and employment, and that not all types of enterprises are common to the samples from the impacted and control areas, the income figures for the impacted and control areas are not easily comparable. However, the income figures are standardised through obtaining income per family labour unit. The Table shows that family labour income level from the enterprises, in general, is higher in the impacted areas, compared to those in the control areas. The only exceptions are enterprises of wood and bamboo products and rickshaw repairing.

Table 8.10 Mean Annual Family Income from Selected Non-farm Activities

Activities	Annual[1] family income (Tk.)		Annual income per family labour	
	Impacted	Control	Impacted	Control
Rice milling	309000	30600	309000	30600
Wood, Cane & bamboo works	4060	25083	4060	12542
Saw mill	87200	-	43600	-
Gur making	26226	6510	20174	3255
Pottery	23075	-	9230	-
Cobbler	29510	-	14755	-
Blacksmithing	23200	-	23200	-
Goldsmithing	16272	-	16272	-
Tailoring	25350	-	25350	-
Carpentry	9000	-	9000	-
Rickshaw repairing	1640	11004	1640	11004
Stationary/Grocery	13015	8900	13015	8900
Rice trading	35760	7865	21035	7865
Rickshaw/Van transport	-	14220	-	14220
Boatmen	16620	17244	16620	8622

Family Income = value of annual output minus annual costs including annual wage bill for hired labours

Source : PIE Case Studies.

8.7 PERCEPTIONS OF BENEFITS FROM THE PROJECT

During the case study, the entrepreneurs' perceptions of benefits from the project were recorded. The perceptions of benefits for development of non-farm activities are presented in Table 8.11. As can be seen from the Table, 14 out of 20 (i.e 70 per cent) of enterprises in the impacted area mentioned that they have benefited from the project. About three quarters of the benefited enterprises appears to have benefited by way of easy transportation, while about half of the enterprises mentioned that they have benefited by way of increased supply of raw material and increased demand for output.

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

Type of benefit	% of benefited respondents
Eased transportation of raw material and output	74
Increased supply of raw material	53
Increased demand for output	53
Others	11
Benefited enterprises	14
% benefited	70

Source : PIE Case Studies

8.8 DAMAGE BY 1988 FLOOD

So far as damage caused to infrastructure and industry is concerned the Project appears to have not reduced the risk of damaging floods; and in 1988 the project area suffered more damage than the control area. However, this does not agree with the data on household flood losses (see Chapter 10).

Table 8.12 gives information on type and extent of damage caused to enterprises by the 1988 flood. As can be seen from the table, out of 20 enterprises in the impacted areas, 6 (i.e. 30 per cent) have suffered losses, as against 5 out of 11 (i.e. 46 per cent) in the control areas. However, the extent of losses caused per enterprise is higher inside the project (Tk.1400 per enterprise) than in the control areas (Tk.300 per enterprise). The implication of the differing incidence of damage by number of enterprises and by value is that the control area is more vulnerable, but the average value of impacted area enterprises is higher. This is in agreement with the evidence on growth of production value (Section 8.6).

Table 8.12 Damage Caused by 1988 Flood

Area	Total sample	No. of units affected by 1988 flood	%	Per enterprise[1] amount of damage on account of					
				Structure	Machinery	Raw material	Output	Working days	Total
Impacted	20	6	30	375	200	510	8	335	1428
Control	11	5	46	145	18	36	36	140	339

[1]averaged over all enterprises

9 GENDER AND NUTRITION IMPACTS

9.1 INTRODUCTION

9.1.1 Limitations

Flood control measures affect the role of both men and women in several ways. Also, the patterns and degree of effect on women are likely to vary with the types of households (farm, labour, fishermen). Then again, tradition and various social factors influence the out-come of any process involving women. This makes the final outcome rather uncertain. Therefore, without a thorough investigation, it is not possible to understand the impact of FCD/I projects on women's lives. The following analysis and description, therefore, will only try to outline the broad direction in which any change may have taken place. Any conclusion that may be drawn will be rather tentative, requiring further validation.

9.1.2 The Areas of Investigation

The analysis that follows fall into 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 these areas, several issues will be picked up for focus.

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

9.2.1 Hiring of Women

In Kolabashukhali, very few women indicated employment outside their houses. Only among the farm families in the impacted area could it be said to be somewhat visible as nearly a fifth of them have admitted to hiring in of female labour (Table 9.1). The incidence of hiring out even among labour households is not as high as found in other PIE areas. A possible reason for such a low incidence is likely to be, among others, a general lack of demand for labour in an almost single cropped area (mixed Aus-Aman which does not need much labour) characterised by a general lack of good communication restricting movement of labour. Nevertheless, there has been some improvement in agricultural output which has prompted more hiring in of female labour in the impacted area compared to the control.

Table 9.1 Employment of Women in Agricultural Activities in Kolabasukhali.
(No. of respondents)

Type of household	Hire in		Hire out	
	Impacted	Control	Impacted	Control
Farmer	13 (21)	3 (10)	2 (3)	3 (10)
Labourer	(0)	(0)	3 (13)	2 (15)
Fishermen	(0)	(0)	(0)	1 (7)
All	13 (13)	3 (5)	5 (5)	6 (10)

Source: FAP 12 PIE Household Survey

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

9.2.2 Agricultural and Non-agricultural Work

Women in the farm households are naturally involved in various agricultural activities, particularly those related to crop processing (see below). Women in labour and fishermen's households are not so involved in such activities since very few of them own any land.

In the case of non-agricultural work the opposite generally holds true. While some 10-15 per cent of women from the farm families have been found to spend some time on non-agricultural activities, the proportion is somewhat higher in the other two types of households (Table 9.2). One exception to this pattern is the fishermen's households in the impacted area; here the percentage of involvement is a little lower than that of the farm households in the same area. A probable reason for the low incidence may be the decline in beel fisheries in the impacted area.

Table 9.2 Incidence of Family Women's Invovement in Non-agricultural Activities in Kolabashukhali.
(No. of respondents)

Occupational group	Impacted	Control
Farmer	9 (15)	3 (10)
Labourer	7 (30)	4 (31)
Fishermen	2 (14)	6 (38)
All	18 (18)	13 (22)

Source: FAP 12 PIE household Survey.

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

9.2.3 Sexual Division of Work in Agricultural Activities

Generally men and women had defined roles in agricultural operations prior to the project. Men were mostly involved in various activities during the pre-harvest and harvesting periods (Table 9.3). Also, they shared threshing activities with women. Not surprisingly, women's work was mostly confined within the household. They were involved in seed preservation, parboiling, husking and storage. To some extent, women also share responsibility for seed preservation and storage with men. The patterns were similar for both impacted and control areas.

Table 9.3 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.	98.4	93.4	3.3	3.3	21.3	19.7	86.7	86.7	-	-	26.7	26.7
Pre-harvest	3.3	3.3	-	-	96.7	96.7	-	-	-	-	93.3	93.3
Harvest	3.3	3.3	-	-	93.4	91.8	-	-	-	-	93.3	93.3
Threshing	65.6	70.5	8.2	9.8	88.5	88.5	56.7	56.7	-	3.3	76.7	76.7
Parboiling	98.4	98.4	11.5	13.1	6.6	4.9	96.7	96.7	3.3	6.7	6.7	6.7
Husking	90.2	86.9	8.2	8.2	4.9	11.5	80.0	76.7	-	-	-	-
Storage	100.0	100.0	3.3	4.9	19.7	19.7	93.3	93.3	-	3.3	26.7	26.7

Source: FAP 12 PIE Household Survey

The project does not appear to have created much change in the basic pattern. Also, there is only a small increase in the employment of hired women as indicated earlier. Compared to the pre-project situation, the work burden of women in case of husking has not fallen. This is in clear contrast to the trend elsewhere. Use of STW engines for husking, which has been the primary cause elsewhere, is conspicuous by its general absence in the KBK area.

9.2.4 Changes in Agricultural Activities of Women in Farm Households.

The direction and magnitude of change in the work burden of women in agricultural activities may be influenced by several factors. A rise in output will demand more of women's time in most of the activities they are engaged in. Of course, the actual outcome in the case of farm family women will depend on how much of the additional workload is shared either by men or hired-women. As there is no prior hypothesis about such substitution the final outcome must be judged empirically.

In Kolabashukhali, impacted area farm households on an average have an output gain of 0.48 mt. of paddy per household, which does not mean much of an additional work burden for husking but compared to the control this is still a third greater. From this, along with the finding that men share work with women in seed preservation, threshing and storage, it is likely that there has been both increase and decrease in workloads in these activities. Parboiling having been the only area of almost exclusively women's work, one would expect to find here the most unambiguous increases.

Table 9.4 shows that the situation is rather mixed in the Kolabashukhali area. In the impacted area more women appear to have experienced an increasing workload (except in husking) than have experencied a decrease. Those who have claimed a decreasing workload in husking outnumbered those who claimed an increase. In the control area a larger number of women have experienced a decreasing workload. Only one respondent in the control area reported that her workload had increased.

The question of employment of women even when there is a substantial change in output may not, therefore, be clearly addressed from the data from the Kolabashukhali area and in general remains an area of further research.

Table 9.4 Changes in Agricultural Activities of Farm Family Women
(No. of respondents)

Activity type	Impacted		Control	
	Increased	Decreased	Increased	Decreased
Seed pres.	15	10	1	6
Pre-harvest	1	0	0	0
Threshing	7	5	0	4
Parboiling	23	19	0	24
Husking	2	8	0	10
Storage	18	17	0	18

Source: FAP 12 PIE Household Survey

In both areas the main reason for increase in women's workload as identified by women is higher output (81 per cent in the impacted and 67 per cent in the control area). Among those who could identify reasons for decreasing workload, respondents in the impacted area identified land loss, flood, water logging, rain and other factors as most important. In the control area flood, water logging, rain, pest attack and other factors are mentioned as three most important reasons for decreasing workload.

9.3 HOMESTEAD PRODUCTION

9.3.1 Number and Types of Trees

Compared to the pre-project situation the average number of trees and plants per household has increased both in the impacted and control areas, but this increase is more noteworthy in the control area than in the impacted area. As they have more land in and

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around the homesteads the farmers' households have the highest number of trees. The labour households of the control area also have a large number of trees. In the impacted area there was no change in the number of trees between pre and post-project period in labour households. A relatively higher percentage increase is seen in the fishermen's group of the impacted area than in the control area. Due to lack of other information it is difficult to hypothesise the reasons for such change (Table 9.5).

Table 9.5 Average Number of Trees In and Around Homesteads in Kolabashukhali

Household type	Impacted		Control	
	Before	After	Before	After
Farmer	54	77 (42)	29	55 (89)
Labourer	35	35 (-)	14	58 (142)
Fishermen	13	31 (138)	7	32 (72)
ALL	44	61 (39)	22	49 (123)

Source: FAP 12 PIE Household Survey

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

Various types of trees are grown in the homestead. To facilitate calculation they have been categorised as fruit-bearing and timber yielding. There is little change over time in the proportion of fruit-bearing trees (from 62 to 71 per cent in the impacted and from 69 to 81 per cent in the control area) in the Kolabashukhali area.

9.3.2 Sexual Division of Work in Caring for Trees

In Kolabashukhali women are involved in tree care and harvest by themselves alone or in association with men. In collection of wood/leaves for use as fuel, women play a prominent role compared to men (Table 9.6). Also in planting and harvest they seem to play a major role in both areas. Their role, as found elsewhere, in tree-felling is less important but is much higher than in other PIE areas, particularly in the impacted area.

It is difficult to assess what may have happened over time in the relative role of men and women in caring for trees. However, it should be noted that both the average number of trees and the percentage of fruit-bearing trees (of all types) have gone up. This indicates that over time the workload of women in general tree-care may have gone up as it is the fruit-bearing trees which demand more attention. On the other hand, it may be possible that the demand for fuel wood by households has remained unchanged, which would reduce the proportion of time spent in collection and gathering of fuel wood/leaves outside home.

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

Type of household	Plantation		Harvesting		Tree-felling	
	Impacted	Control	Impacted	Control	Impacted	Control
Farmer	43 (68)	22 (73)	52 (83)	29 (97)	31 (49)	7 (23)
Labourer	15 (65)	7 (54)	18 (78)	9 (69)	11 (48)	5 (39)
Fishermen	10 (67)	8 (53)	11 (73)	10 (67)	11 (74)	6 (40)
All	68 (69)	37 (64)	81 (82)	48 (83)	53 (54)	18 (31)

Source: FAP 12 PIE Household Survey

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

9.3.2 Vegetable Production: Incidence and Sex Roles

Tiny (0.6 decimals to 1.56 decimals) vegetable production plots are found in all sample households in Kolabashukhali. It appears from the information collected in the field that there has been a significant increase, especially in the impact area, in the area so cultivated. Among occupational groups the most noticeable change has occurred in fishermen households of the impacted area and labour household in the control area over the pre-project situation.

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

9.3.3 Poultry Keeping: Relative Sex Roles

Women's role in poultry keeping seems to be pronounced in Kolabashukhali (Table 9.7), but there appears to be little difference between the two types of areas in the relative roles of women.

Table 9.7 Incidence of Participation by Women in Decision on Poultry Keeping
(No. and % of women responding positively)

Household type	Sale		Purchase		Sale money use	
	Impacted	Control	Impacted	Control	Impacted	Control
Farmer	33 (54)	13 (43)	35 (57)	18 (60)	35 (57)	15 (50)
Labourer	10 (44)	6 (46)	8 (35)	7 (54)	11 (48)	4 (31)
Fishermen	8 (53)	8 (53)	5 (33)	5 (33)	10 (67)	8 (53)
All	51 (52)	27 (47)	48 (49)	30 (52)	56 (57)	27 (47)

Source: PIE Household Survey

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

9.3.4 Homestead Income and Its Use

Table 9.8 shows the estimated income from household production per household by source and type of household for the impacted and control areas. It seems that the average homestead income is higher in the impacted compared to the control area, but only by a small margin. In both areas poultry are the major homestead based source of income. Eggs in general are the next most important source of income.

It should be noted that it is the farmers who gain most from the homestead production. There may be several reasons for that. They can grow vegetables on comparatively larger plots of land and they can raise more chickens and ducks which are better fed and cared for because of the higher agricultural output of such households.

Very few households sell vegetables or poultry. As such it is difficult to make any comment on the general pattern of sex-difference in receipt of sale money. In Kolabashukhali the proportion of women who receive the cash appears to be similar to that of men. There is no clear impact-control difference.

In most cases homestead income accures in kind and almost all of it is consumed by the household. Most of the women who answered the question on use of sale money identified it being mostly spent to meet household needs. Only a few women reported that they use the sale money for personal purposes.

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Table 9.8 Average Returns from Homestead Production in Kolabashukhali (Tk./household/annum)

Household type	Impacted				Control			
	Vegetable	Poultry	Egg	All	Vegetable	Poultry	Egg	All
Farmer	354 (34)	440 (42)	259 (25)	1053 (18)	180 (20)	442 (50)	269 (30)	891
Labourer	83 (26)	142 (44)	98 (30)	323 (-31)	98 (21)	224 (48)	144 (31)	466
Fishermen	90 (22)	197 (47)	131 (31)	418 (-34)	70 (11)	411 (65)	152 (24)	633
All	251 (32)	334 (42)	203 (26)	787 (8)	133 (18)	385 (53)	211 (29)	729

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.

9.3.5 Group Activities

Few women (twenty women in total) were found to be involved in group activities. Women of the farm households were mostly involved in such activities in both impacted and control areas. Most women were involved with NGO groups. It is interesting to note that in general the women of the impacted area were more involved in such group activities.

9.4 NUTRITIONAL ISSUES

9.4.1 Caveats

A rise in income of the people living within the project area, it is hoped, would lead to their better nutritional status. As a full-fledged nutritional survey was not possible within the scope of this study, only the level of intake of most frequently consumed foods (rice, wheat, parched rice and pulses) were emphasised and attempts were made to draw out women's ideas about adequacy in rice consumption.

In rural Bangladesh nearly 84 percent of the total calorie intake comes from the four types of foods mentioned above (BBS; 1991). Total calorie and protein consumption in the sampled households were estimated using this ratio. It should be noted that as in most one-time surveys, these investigations may have resulted in seasonal biases in the estimates. The timing of the field work, however, did not indicate any particular reason for deviation from the average seasonal condition.

9.4.2 Food and Calorie Intake

The estimated average per capita consumption of rice and energy is presented in Table 9.9. On both counts the impacted and control area households are rather similar. However, the farmer are somewhat fortunate than others in the sense that their intake is slightly higher while in other cases the consumption is lower in the impacted area.

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Table 9.9 Per Capita Daily Rice and Calorie Intake in Kolabashukhali

Household type	Rice (gms)		K calorie	
	Impacted	Control	Impacted	Control
Farmer	573 (9)	527	2766 (4)	2671
Labourer	429 (.5)	427	2146 (-12)	2432
Fishermen	424 (-.7)	427	2246 (-8)	2438
All	521 (9)	480	2562 (1)	2560

Source: FAP 12 PIE Household Survey
Note: Figures in parentheses indicate percentage differences over control.

9.4.3 Poverty Profile

A profile of the households on the basis of calorie intake was estimated by using the amount of calorie consumed and is presented in Table 9.10. The households are divided into three groups: (a) those who consume at most 1805 Kcal/person/day are classified as hard core poor, (b) those who consume between 1805 and 2122 Kcal/person/day are classified as absolute poor and (c) those consuming over 2122 Kcal/person/day are classified as non-poor.

These data confirm that nutritionally there is negligible difference between sample households in the impacted area and control area households. In the impacted area the proportion of non-poor households are somewhat higher (74 percent) than that of the control area (68 percent). But again the farmers appear to be the most non-poor category. It is the labour households who suffers most (more than 40 per cent) from nutritional poverty.

Table 9.10 Distribution of Households by Level of Poverty in Kolabashukhali (No. of households)

Household type	Hard core		Absolute		Non-poor	
	Impacted	Control	Impacted	Control	Impacted	Control
Farmer	5	1	4	7	52 (85)	25 (83)
Labourer	7	4	3	2	13 (57)	7 (54)
Fishermen	3	2	4	5	8 (53)	8 (53)
All	15	7	11	14	73 (74)	40 (68)

Source: FAP 12 PIE Household Survey
Note: Figures in parentheses indicate percentages of total number of respondents by category

9.4.4 Adequacy of Food Intake

Women were questioned regarding adequacy of food intake by individual family members. Although on objective measurement (Table 9.10) there is little difference between the impacted and control areas, a higher percentage of farm household women reported inadequate intake in the control area than in the impacted area (Table 9.11). In the case of other groups in which the sense of deprivation is stronger, there is little difference between the impacted and control areas.

9.4.5 Gender Differences in Food Intake

The difference in rice intake of adult men and women and that between boys and girls of about 8 years of age were used as two indicators for gender-differences in food intake. There is little difference in food intake of the latter group, In contrast, one finds significant difference in intake of adult men and women. In both areas women were found to consume 25-30 per cent less than adult men (Table 9.11).

Table 9.11 Adequacy of and Gender Differences in Food Intake in Kolabashukhali

Household type	Percent stataing inadequacy		Women/men ratio in rice intake (%)	
	Impacted	Control	Impacted	Control
Farmer	13	33	75	73
Labourer	83	85	72	70
Fishermen	33	27	69	74

Source: FAP 12 PIE Household Survey

9.4.6 Consumption of Non-Grain Food

It is expected that with a rise in income consumption of non-grain food would increase, as the income-elasticity of such types of food is high. Whether this has occurred in the project areas experiencing growth in output has been tested in a very crude manner, by looking at the frequency of consumption of such foods. Incidence of consumption of meat, fish, egg and milk over the week preceeding the survey is presented in Table 9.12. Conclusions that could be drawn from the data are:

- the most frequently consumed non-grain food is fish. All fishermen and more than 90 percent of the farmers of both areas have consumed fish during the reference week. In labour households the frequency is much lower;

- in both areas meat appears to be the least consumed food. Only farmers in the impacted area appear to have consumed meat fairly frequently;

- frequency of consumption of egg is fairly high among all groups except labourers of both areas and fishermen of the control area;

- milk is consumed mainly by the farmers. There is little difference between the impacted and control areas in milk consumption.

Table 9.12 Incidence of Consumption of Non-grain Food During the Last 7 Days in Kolabasukhali

Food type	Farmer		Labourer		Fishermen	
	Impacted	Control	Impacted	Control	Impacted	Control
Meat	18 (30)	3 (10)	0 (0)	2 (15)	0 (0)	1 (7)
Fish	56 (92)	28 (93)	14 (61)	10 (77)	15 (100)	15 (100)
Egg	31 (51)	18 (60)	6 (26)	1 (8)	10 (67)	5 (33)
Milk	32 (53)	15 (50)	0 (0)	4 (31)	2 (13)	5 (33)

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

Most of the sample households (59 per cent in the impacted and 64 per cent in the control) cook at least twice a day. Many cook three times a day. Thus only a very small percentage of households cooks once a day and eat cold meals which is an unhealthy practice from the nutritional point of view and an indicator of food shortage in the household.

9.4.8 Incidence of Starvation

Despite a growth in annual income, people may still starve partly or fully during part of the year due to seasonal lack of employment and income. In aggregate, the pictures in the impacted and the control areas are quite similar. The incidence of starvation has increased in both cases and at similar rates. Nevertheless, the situation may be slightly better in the impacted area particularly for the farmers (Table 9.13).

Table 9.13 Incidence of Starvation in Pre- and Post-Project Situation in Kolabashukhali
(No. of respondents)

Household type	Impacted		Control	
	Before	After	Before	After
Farmer	26 (43)	33 (54)	17 (56)	19 (63)
Labourer	21 (91)	22 (97)	9 (69)	11 (85)
Fishermen	7 (47)	9 (60)	6 (40)	10 (67)
All	54 (55)	64 (65)	32 (55)	40 (69)

Source: FAP 12 PIE Household Survey
Note: Figures in the parentheses are percentages of total number of respondents.

9.4.9 Seasonality in Starvation.

In rural areas starvation is related to the seasonal peaks and troughs of economic activities. In general one expects a rise in dietary intake of farmers and labourers in the early winter period in places where Aman is the major paddy crop and a low incidence of starvation during this period (Bengali months of Poush and Magh). This is a period of peak income for fishermen too, because the catches are good during winter and effective demand for fish is at a high level. Another period of low incidence of starvation occurs in or around May in places where Boro is an important crop. Level of income and employment fall progressively from then unless Aus is a major crop, and reach their lowest point before Aman harvest (Bengali months of Kartik and Agrahayan) when incidence of starvation reaches its peak.

In Kolabashukhali the most important crop is mixed Aus/Aman. The incidence of Aus is lower in the control area than the impacted but sugarcane is harvested at roughly the same time as Aus. However, there is little Boro due to lack of irrigation. One therefore would expect a comparatively high incidence of starvation during the rabi period which would either take a dip or remain stagnant over the Aus season finally falling to its lowest level before and during the Aman harvest. The dip in the case of Aus and Boro are not prominent.

Figures 9.1- 9.3 conform with the above hypothesis. In the case of farmers, the highest incidence of starvation occurs during the months of Baishakh-Jaistha (Boro-harvest) as there is little Boro cultivation, while the predominance of mixed Aus/Aman followed by Aman results in a somewhat complex situation in the impacted area. In the control area, as both the major crops are in the same season, roughly speaking, the movements are much sharper. As the impacted and control areas are contiguous the predominance of Aus/Aman also results in a shifting of the peaks of starvation (towards Bhadr-Ashwin from Kartik-Agrahayan) for the labour households. For fisherman there is no difference between the two areas.

9.4.10 Adjustment Mechanisms

When the prospect of starvation looms large, people either borrow or eat less to cope with the situation (Table 9.14). This is true in both areas and across all occupational groups. However, on looking closely one finds some differences between the occupational groups. Borrowing seems to be the preferred measure of adjustment among farmers of both areas, while labourers and fishermen prefer to adjust within the household by eating less.

A good number of farmers in the control area (37 per cent) and fishermen in the impacted area (29 per cent) have also sold off their assets to generate cash for buying food.

Although the burden of adjustment is shared, it falls more on women than other family members. Twelve per cent of the women in the impacted area and 22 per cent in the control area reported that they eat less when their family faces periods of starvation. A general rise in the economic well-being of the impacted area therefore is no guarantee that in times of distress women will not face greater deprivation.

Figure 9.1 Starvation in Kolabashukhali (Farmers)

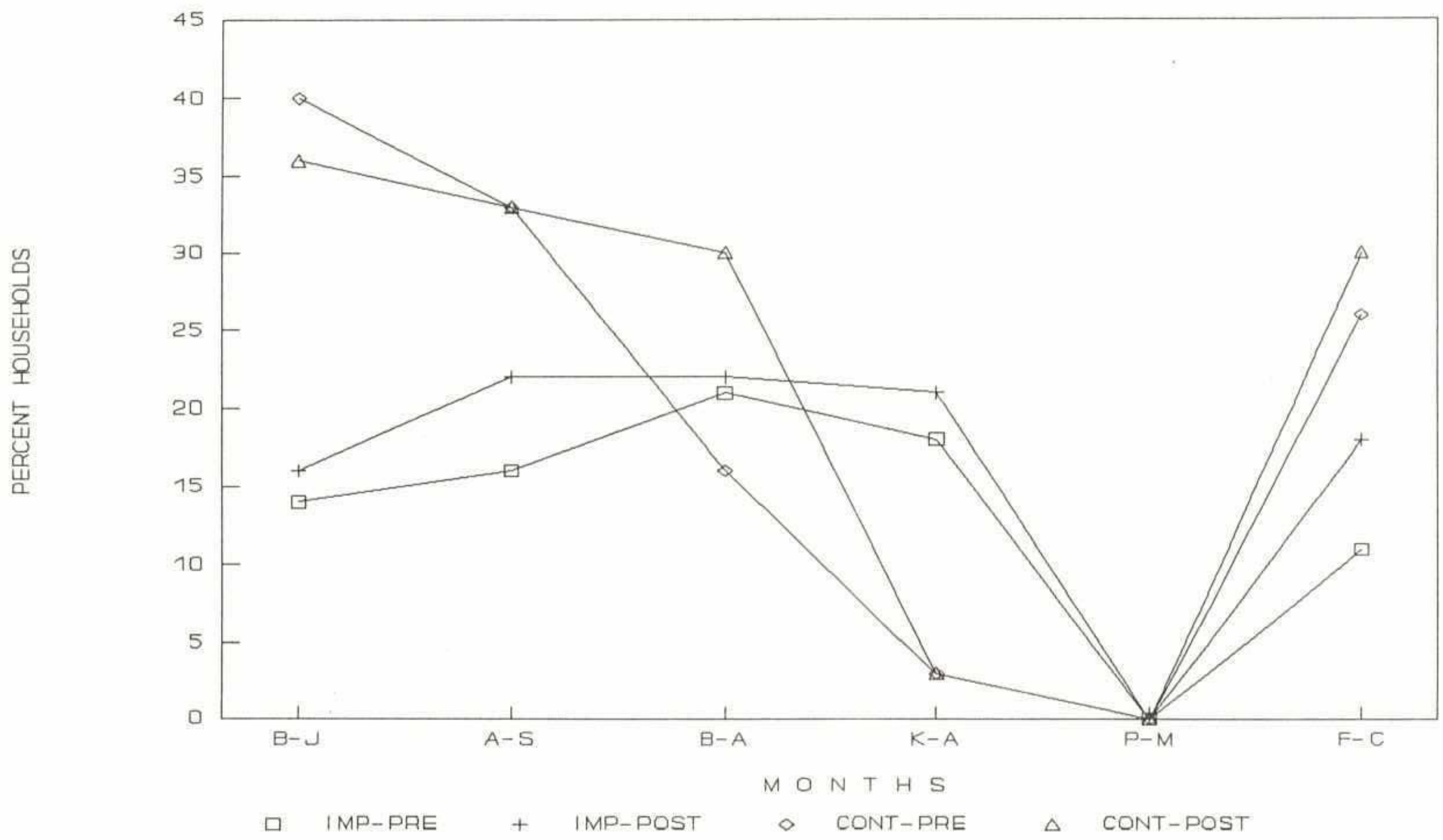

Figure 9.2 Starvation in Kolabashukhali (Labourers)

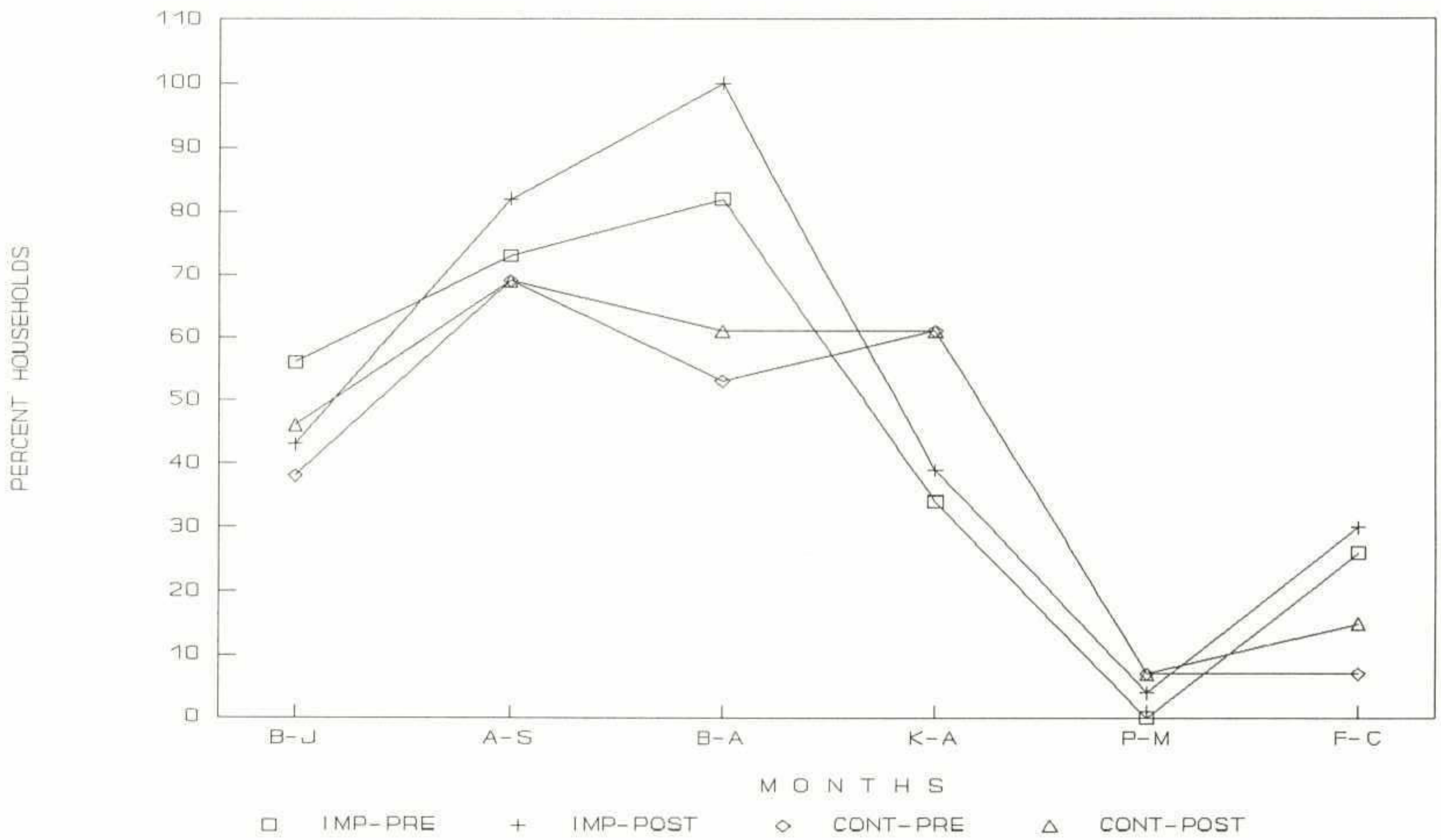

Figure 9.3 Starvation in Kolabashukhali (Fishermen)

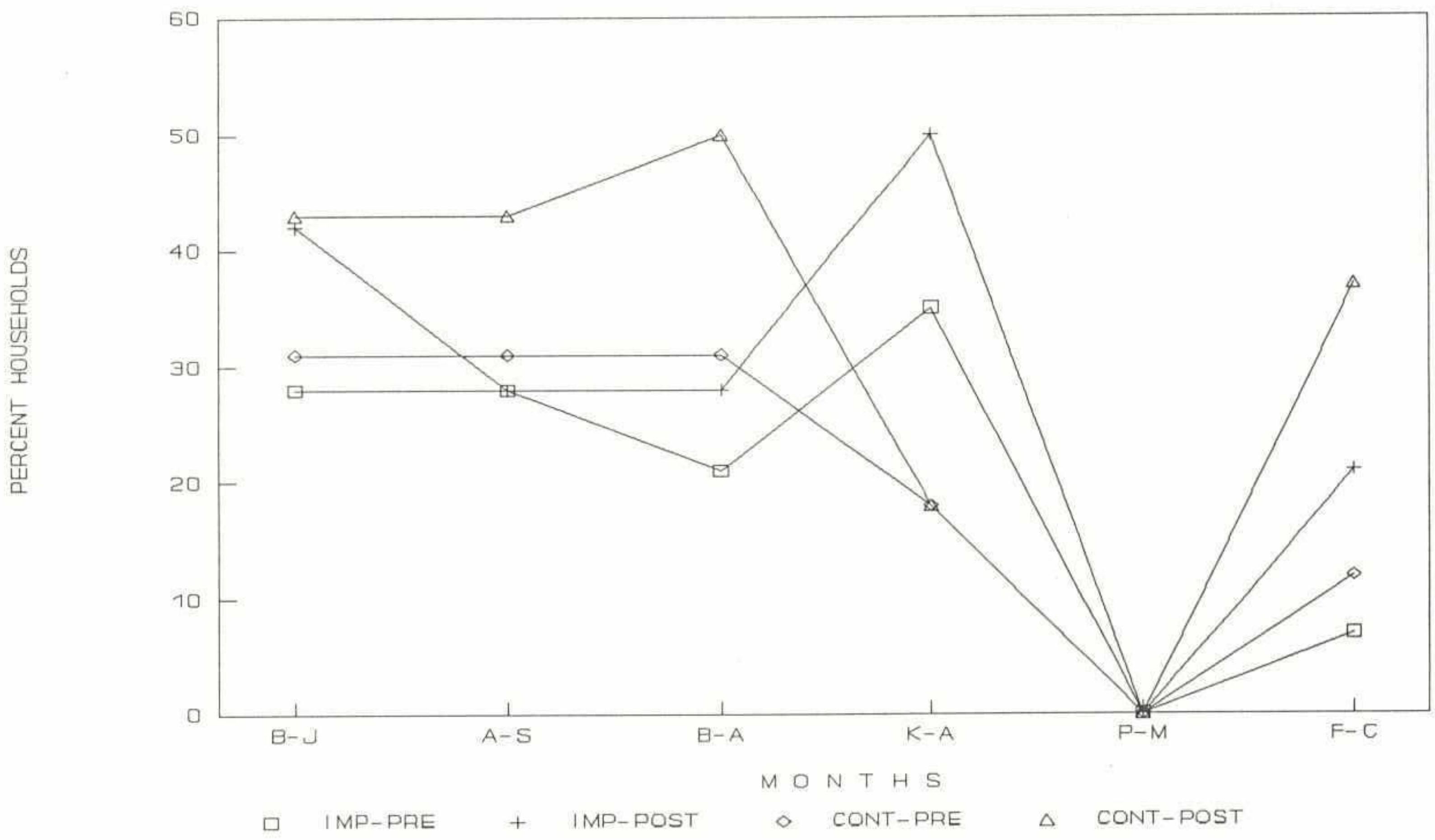

Table 9.14 **Measures to Cope with Starvation in Kolabasukhali**
(No. and % of response)

Type of measure	Farmer		Labourer		Fishermen		All	
	Impacted	Control	Impacted	Control	Impacted	Control	Impacted	Control
Borrowing	21 (34)	14 (47)	14 (61)	8 (62)	7 (47)	6 (40)	42 (42)	28 (48)
All ate less	20 (33)	7 (23)	17 (74)	12 (92)	8 (53)	6 (40)	45 (46)	25 (43)
Women ate less	7 (12)	9 (30)	4 (17)	2 (15)	1 (7)	2 (13)	12 (12)	13 (22)
Others ate less	- (-)	1 (3)	- (-)	- (-)	- (-)	1 (7)	- (-)	2 (3)
Disin-vestment	10 (16)	11 (37)	4 (17)	2 (15)	4 (27)	1 (7)	18 (18)	14 (24)
Others	15 (25)	- (-)	13 (57)	2 (15)	2 (13)	5 (33)	30 (31)	7 (12)

Source: FAP 12 PIE Household Survey
Note: Figures in parentheses indicate percentages of total number of responses by category of household

9.4.11 Access to Safe Water

The use of safe water for drinking is almost universal in both the impacted and control areas and occurs in all types of household (Table 9.15). In the case of cooking and cleaning, as elsewhere, the reliance on safe water progressively diminishes.

Table 9.15 **Present Sources of Water by Type of Use in Kolabashukhali**
(No. and percentage of total response by category of use by the type of household concerned)

Household type	Area	Cleaning		Cooking		Drinking	
		Safe	Unsafe	Safe	Unsafe	Safe	Unsafe
Farmer	Impacted	8 (13)	53 (87)	20 (33)	41 (67)	60 (98)	1 (2)
	Control	5 (17)	25 (83)	8 (27)	22 (73)	30 (100)	-
Labourer	Impacted	3 (13)	20 (87)	7 (30)	16 (70)	21 (91)	2 (9)
	Control	2 (15)	11 (85)	3 (23)	10 (78)	13 (100)	-
Fishermen	Impacted	-	15 (100)	5 (33)	10 (67)	14 (93)	1 (7)
	Control	-	15 (100)	6 (40)	9 (60)	13 (87)	2 (13)
All	Impacted	11 (11)	88 (89)	32 (32)	67 (68)	95 (96)	4 (4)
	Control	7 (12)	51 (88)	17 (29)	41 (71)	56 (97)	2 (4)

Source: FAP 12 PIE Household Survey
Note: Figures in parentheses indicate percentages of total number of responses by category of household

9.4.12 Problems of Water Quality and Associated Changes

Most women (87 per cent in the impacted and 78 per cent in the control area) complained about changes in physical quality of water. The incidence of disease from drinking such water is also high.

Gastroenteric disease is quite common in the sample households (Table 9.16). Fever and skin diseases were mentioned as other common diseases among adults and minors.

Table 9.16 Incidence of disease by Type in Kolabashukhali
(Total cases and average number per household)

Type of disease	Impacted		Control	
	Adults	Minor	Adults	Minor
Gastroenteric	26 (.26)	35 (.36)	24 (.40)	22 (.37)
Skin	13 (.13)	8 (.08)	16 (.27)	10 (.17)
Fever	21 (.21)	15 (.15)	18 (.30)	15 (.25)
Others	5 (.05)	7 (.07)	2 (.03)	4 (.06)

Source: FAP 12 PIE Household Survey

Note: Figures in parentheses are average number of cases of illness per household.

9.5 PROBLEMS FACED BY WOMEN DURING FLOODS

Households suffer many problems during floods. Those affecting women most adversely are presented in Table 9.17. During floods most women, both of the impacted and control area, suffer from lack of toilet facilities. Other major problems were lack of dry space for cooking and getting safe drinking water, in that order. It may be noted that in general the incidence of such problems are somewhat less in the impacted area.

Table 9.17 Problems Faced by Women During Floods in Kolabashukhali
(% of respondents - all groups)

Type of problem	Impacted	Control
Dry space	17 (17)	20 (35)
Drinking water	22 (22)	23 (40)
Toilet	32 (32)	30 (52)
Cooking	31 (31)	23 (40)
Food availability	11 (11)	11 (19)
Movement	13 (13)	9 (16)
Homelessness	1 (1)	2 (4)
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 SOCIO-ECONOMIC IMPACTS

10.1 BACKGROUND

The Kolabashukhali Project area is a tidal river island, surrounded by rivers on four sides. In the pre-project period, there were no flood control structures and the low lying parts of the project area used to be occupied by extensive beels, which were not only perennial spots for fishing, but also facilitated water transport by boats. The inundation of large parts of the project area twice daily, intrusion of saline water in low water season and the virtual absence of road communication meant that there were virtually no government or NGO activities for socio-economic development of the project area.

The declared objectives of the project did not include any target for socio-economic development. However, this is one of the projects which was intended to upgrade internal communication through the construction of an internal road network. The lack of explicit social objectives or mitigatory measures is an important shortcoming in the project planning - socio-economic gains have occurred but regulation could have targeted benefits to the poor or disadvantaged groups. Particular issues are the allocation of new cultivable land which was public property, the loss of common property resources due to the draining of beels for cultivation (which cause low income groups to lose access to fisheries and grazing land), the growth of wage labour, and the potential to target direct project employment (construction and maintenance) at destitute women and other low income groups.

10.2 DEMOGRAPHIC CHARACTERISTICS

The sample households were in general headed by males irrespective of occupational category or study area (impacted or control). There is little difference in the age of the household heads between the impacted and control areas.

The average family size varies between 5 and 7, labourer households having slightly smaller households than other categories (Table 10.1). It should be noted that the "others" category is a non-random sample of households in other occupation categories, and the "labourer" category is referred to as non-cultivators in other tables and consists almost entirely of labourers but with a few other non-cultivating households. The households of different occupational categories in the impacted area had in general a higher proportion of literate heads than in the control area, but this must date to long before the project and is not related to the educational facilities impacted by the project. There is an absence of any systematic pattern with respect to the proportion of school age boys and girls actually attending school (Table 10.1).

10.3 OCCUPATIONS AND EMPLOYMENT

10.3.1 Household Occupation

The average number of earners per household is less than two and there is no systematic difference in the number of earners between the impacted and the control areas (Table 10.2), but labouring households have fewer earners. In general, a slightly higher proportion of studied households in the control area had involvement in secondary occupations, compared with the impacted area. This may be partly explained by the increased occupational involvement in cultivation in the impacted area, which has improved due to the project both in terms of increased area and output.

Table 10.1 Demographic Characteristics of the Households and Population in Kolabashukhali

Characteristics	Farmer		Labourer		Fishermen		Others	
	Impacted	Control	Impacted	Control	Impacted	Control	Impacted	Control
Family size	6.7	6.4	5.5	4.9	7.1	6.7	6.8	5.3
Sex- ratio[1]	112	119	100	90	80	113	123	112
Dependency ratio[2]	3.9	3.8	4.0	3.6	4.1	3.5	3.8	6.5
% literate households	57	52	35	29	53	13	67	69
% boys attending school	84	92	56	46	100	84	83	53
% girls attending school	76	80	55	63	62	54	68	100

Note [1] Number of males per 100 females
[2] Number of non-earners per person engaged in income generating activities (i.e. domestic saving activities counted as "dependent".

Source: PIE Survey, 1991

Table 10.2 Occupations of Households in Kolabashukhali Project

Criteria	Farmer		Labourer		Fishermen		Others	
	Impacted	Control	Impacted	Control	Impacted	Control	Impacted	Control
No. of earner per hh	1.74	1.71	1.38	1.38	1.73	1.93	1.78	0.81
% hh heads with 2nd occupation	37	41	24	25	67	60	33	44
Incidence of other Prim. occup.[a]	23(11)	9(9)	7(11)	5(15)	2(8)	2(7)	4(12)	8(62)
Incidence of second occup.[b]	59(28)	32(32)	14(22)	5(15)	16(62)	19(66)	6(19)	13(100)

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

Source: PIE Survey, 1991

10.3.2 Occupational Changes

There appears to have been little occupational change in the post-project period. The proportion of cultivator households in the impacted area during the post-project period was slightly higher than in the pre-project period, whereas their proportion in the control areas actually declined to some extent (Table 10.3). A small number (three) of non-agricultural labourers have moved into agriculture. Overall, there has been a little more occupational mobility in the impacted area, in terms of a higher proportion of households engaged in rickshaw pulling and other transport works, boat plying, petty trades and salaried jobs during the post-project period, but the differences are very small (Table 10.4). The ratio of percentages of earners changing main income source in the impacted and control areas since project completion was respectively 12:8. The slight diversification of occupations in the project area into rickshaw pulling, petty trades and salaried jobs may be due to the improvement in the internal road communication network, an intended objective of the project. This has contributed to slightly more non-farm economic activity, especially in rice milling and trading and input marketing (see Chapter 8).

Table 10.3 Main Earners' Main Occupation before and after the Project, Kolabashukhali

Occupation	Impacted		Control	
	Pre-project	Post-project	Pre-project	Post-project
No households	167	168	84	84
Cultivator (%)	70	72	73	71
Agri. Labour (%)	25	26	27	29
Fisherman (%)	0	0	0	0
Transport (%)	1	1	0	0
Trade (%)	0	0	0	0
Salaried service (%)	1	0	0	0
Nonfarm labour (%)	2	1	0	0
Non-earning (%)	2	0	0	0

Source : PIE Survey.

Table 10.4 Occupations of all earners in Kolabashukhali

	OCCUPATION BEFORE				OCCUPATION AFTER			
	IMPACTED		CONTROL		IMPACTED		CONTROL	
Self Cultivation	171	52.1%	80	54.1%	191	54.9%	93	53.4%
Cult. with hired labour							1	.6%
Agri. Lab.	66	20.1%	37	25.7%	73	21.0%	48	27.6%
Fishing	3	0.9%	2	1.4%	5	1.4%	4	2.3%
Business/Shopkeeping	2	.6%			2	.6%		
Carpentry	2	.6%			1	.3%		
Masonry Work					1	.3%		
Rickshaw Pulling	2	.6%			3	.9%		
Boatmen.	1	.3%		2.0%	2	.6%		
Cart Driving					1	.3%		
Other Transport work	2	.6%	3		3	.9%	3	1.7%
Petty Trade	17	5.2%	12	8.1%	18	5.2%	14	8.0%
House maid/servant	1	.3%		3.4%	1	.3%		
Salaried service	16	4.9%	5		27	7.8%	6	3.4%
Other Non-agri. lab	11	3.4%	1	.7%	10	2.3%	1	.6%
Housewife			1	.7%			1	.6%
Student	27	8.2%	7	4.7%	2	.6%	1	.6%
All others	8	2.4%			8	2.3%	2	1.1%
Total Cases	328	100%	148	100%	348	100%	174	100%

Source : PIE Surveys

10.3.4 Employment Changes

The direct employment created by the project was in the form of construction of the embankment, internal roads, drainage and/or flushing sluices, drainage channels and culverts, which brought about employment mostly in earth work for the poorer households (both cultivators and non-cultivators) from the project and the adjacent areas.

The expansion of cultivated area and increased production of paddy has increased crop sector employment accruing both to family and hired labour. Table 10.5 shows that the agricultural labour households interviewed in the PIE survey reported 219 days of employment in the impacted area and 193 days of employment in the control area during the year 1990-91, difference of about 13 per cent. The higher level of employment was also associated with consistently higher wages in the impacted villages than in the control villages, meaning higher wage income earned by the labour households in the impacted villages than those in the control areas (see Section 10.4). The data are consistent with the evidence for positive agricultural impacts (see Chapter 5).

Table 10.5 Agricultural Labourers' Employment and Wage Rates 1990-1991, Kolabashukhali

Months	Days Employed				Mean wage rate Tk. (day)	
	Impacted		Control		Impacted	Control
	Mean	% days in project	Mean	% days in project		
Baishak	17	97	10	0	28	26
Jaistha	18	92	16	0	28	25
Ashar	18	84	16	0	31	26
Sravan	20	81	16	0	34	28
Bhadra	17	89	14	0	30	27
Aswin	16	87	14	0	29	26
Kartik	15	88	17	0	29	27
Agrahayan	22	90	21	0	33	31
Poush	21	91	18	0	34	29
Magh	19	91	16	0	31	25
Falgun	18	96	17	0	28	25
Chaitra	18	97	18	0	28	26
Total	219		193		30.25	26.75

Source : PIE Surveys

Despite this increase in on-farm employment, there also appears to have been a relatively greater increase in out-migration among the impacted area households (Table 10.6). However, there does not appear to be any notable difference in the seasonal pattern of migration between project and control areas, except that the relative importance of Aman season migration has declined with the expansion of Aman cultivation in the project area.

Table 10.6 Percentage of Migrating households reporting moving by season, Kolabashukhali

Season	Impacted		Control	
	Pre	Post	Pre	Post
Aus	60	62	60	57
Aman	30	19	20	29
Boro/Rabi	10	14	-	-
Aman+Boro	-	-	20	14
All season	-	5	-	-
No hh migrating	10	21	5	7

Source : PIE Surveys

10.4 INCOME DISTRIBUTION

The PIE survey shows that overall the households in the impacted villages had 9 per cent higher income per household, 8 per cent higher income per person and 8 per cent higher income per earner than the households in the control villages (Table 10.7). Both landholding and landless households appear to be better off in the impacted area than in the control area and this was corroborated by peoples' opinions recorded in the PIE survey. The same table also shows that the lowest landholding category, practically equivalent to landless category (landholding $\leq$ 20 dec.), had about 40 per cent higher income in the impacted area than in the control area, whereas the highest landholding category (landholding above 750 dec.) had only 20 per cent higher income in the impacted villages than in the control villages. This suggests a less inequitable impact on incomes in this project than in other PIE Projects.

Table 10.7 Household Income by Landholding Category Kolabashukhali (Tk in 1990-91)

Landholding	No. hh	Impacted			No. hh	Control		
		Tk/hh	Tk/person	Tk/earner		Tk/hh	Tk/person	Tk/earner
$\leq$ 20d	50	13243	2518	10510	26	9168	1877	6443
21-100d	37	17130	3138	10564	17	21208	3717	15023
101-250d	46	21329	3455	12419	20	20119	3245	12574
251-500d	25	41439	5368	19547	11	37656	5834	23012
501-750d	5	44512	5857	27820	6	24881	3176	13572
+750d	5	57540	8220	28770	4	47997	5052	13713
All hh	168	22703	3767	14005	84	20914	3486	12917

Source : PIE Surveys

This is confirmed by comparing cultivating and non-cultivating households, Kolabashukhali is unusual in that non-cultivating households are 35 per cent better off in the project area, whereas cultivating households are only 5 per cent better off on average (Table 10.8). However, in parts of the project area there were crop damages in 1990-91 due to localised storms which did not appear to affect the control area so badly, so the survey data may understate the incomes of farming households.

Table 10.8: Comparison of Incomes of Farm and Non-Farm Households, Kolabashukhali

	Cultivate		Non-cultivator	
	Project	Control	Project	Control
People/hh	6.4	6.4	5.1	4.9
Tk/hh	26696	25609	12914	9176
Tk/person	4166	3981	2520	1866
Project v control	+5%		+35%	
Cultivate v non cultivator	+65%	+113%		

Source : PIE Surveys.

As regards sources of income, cultivation provided the largest source of income in both the impacted and control areas. Salaries are quite important in both areas but made the second highest contribution to total income in the impacted area, perhaps due to the relative proximity of the area to Khulna city and the presence of two Upazila towns within the project (Table 10.9).

The incidence of wage labour among households with 1-5 acres in the control area suggests that these households are relatively less well off than similar households in the Project area.

Capture fishermen, as in other FCD/I projects, have suffered loss of catches from the reduction of flood depth and duration, and reclamation of low lying areas for agriculture, but those who had a right to land that was occupied by beels, and who now cultivate that land, have benefited. However, because lands have been reclaimed for cultivation in this project, problems over the distribution of public (khas) lands, for example, have affected the distribution of assets and hence income gains (Section 10.5). It is not clear from the PIE survey who this benefit has gone to (the evidence for increased cultivated area came from the RRA), but the lack of difference in income of cultivating households suggests that more households may now be cultivating.

10.5 LANDHOLDING AND LAND ACQUISITION

10.5.1 Land Holdings

The PIE survey results relating to changes in landholding since the project (essentially land acquisition and transactions) show that about 38 per cent of households changed landholding size in the impacted area as against 31 per cent of households in the control area

(Table 10.10). A notably higher proportion of households in the impacted villages (15 per cent) had increased their holding, compared to 6 per cent of households increasing holding size in the control areas. The proportion of households experiencing a decrease in landholding was slightly higher in the control area than in the impacted areas. Moreover, over the project period the households in the impacted areas gained considerably more land than they lost, whereas the households in the control areas sold much more land (Table 10.11). It is not clear which group has been acquiring land in the control area. However, the results are consistent with more households in the impacted area having increased their holdings through the conversion of beels into agricultural land, made possible by the reduction of flood depth and duration due to the project.

Table 10.9 Source of Household Income by Landholding Class, Kolabashukhali

a) Impacted area

Landholding	No. hh	Percentage of income from:										
		Cultivation	Trees	Homestead	Livestock	Salaries	Business	Rents	Crafts	Fishing	Transport	Wage labour
< 20d	50	0	7	2	6	8	2	1	3	2	5	58
21-100d	37	30	12	3	3	5	0	0	17	4	0	26
101-250d	46	50	10	2	10	14	0	0	8	3	0	3
251-500d	25	49	10	2	1	27	6	3	0	2	0	0
501-750d	5	44	15	4	-4	36	0	4	0	1	0	0
+750d	5	69	6	7	2	0	0	15	0	0	0	0
All hh	168	39	10	3	4	15	2	2	6	2	1	15

b) Control area

Landholding	No. hh	Percentage of income from:										
		Cultivation	Trees	Homestead	Livestock	Salaries	Business	Rents	Crafts	Fishing	Transport	Wage labour
< 20d	26	3	10	2	4	0	0	1	8	5	0	68
21-100d	17	47	9	2	7	13	0	0	4	2	0	16
101-250d	20	55	8	2	10	2	0	1	8	5	0	8
251-500d	11	65	12	1	7	0	0	10	2	1	0	2
501-750d	6	38	8	1	8	21	0	8	12	3	0	0
+750d	4	41	9	1	8	38	0	2	0	1	0	0
All hh	84	46	10	2	8	9	0	4	5	3	0	15

Source : PIE Surveys

Table 10.10 Number of Households Experiencing a Change in Landholding since Project Completion, Kolabashukhali

	Impacted	Control	Total
Increase	25 (14.9)	5 (6.0)	30 (11.9)
No Change	104 (61.9)	58 (69.0)	162 (64.3)
Decrease	39(23.2)	21 (25.0)	60 (23.8)
Total	168	84	252

Source: PIE Survey 1991

Table 10.11 Timing and Amount of Land Transactions (in decimals) by Surveyed Households, Kolabashukhali

Year	Project		Control	
	Purchased	Sold	Purchased	Sold
1985	159	0	75	238
1986	128	0	29	67
1987	184	139	14	429
1988	244	109	8	52
1989	445	399	65	60
1990	853	698	84	681
1991	96	24	8	138
All years	2109	1369	283	1665

Source : PIE Survey 1991

These changes appear to have been widely spread, but there were some changes between landholding categories. In the project area 5 per cent of households moved up a category (and one landless household became a small farmer), while 8 per cent fell to lower categories, whereas in the control area only 3 per cent moved up a category and 8 per cent moved down a category.

In general, prices of different types of land have risen more in the impacted area than in the control area over the post-project period (Table 10.12). This is especially the case for non-irrigated land (most of the area) where project area prices were lower than in the control area before the project, but are now at least as high, reflecting the benefits of flood protection. Irrigated land is a small fraction of the total area and as it tends to be higher land there is little extra gain from the Project.

Table 10.12 Land Price in Kolabashukhali (Tk.dec)

Irrigation status/period	Impacted, protected			Control		
Irrigated	H	M	L	H	M	L
Pre-project	200	125	70	150	175	150
Post-project	500	300	188	480	300	225
% Change	+150	+140	+168	+220	+71	+50
Non-Irrigated						
Pre-project	292	202	148	381	269	265
Post-project	604	431	320	570	393	358
% change	+107	+113	+116	+50	+46	+35

Note: H = Highland, M = Medium Land, L = Low land
pre-project = about 1980; post-project = mid 1991

Source : PIE Survey, 1991

An area of landholding changes which is probably not picked up by the PIE surveys is the usurping of previously khas land for cultivation following the project. In some cases fishermen had title to land in the beels and so gained from new cultivation, but there were also considerable areas of khas land. However, the RRA did not reveal anyone who had benefited, or who knew anyone who had benefited, from the distribution to landless or marginal farmers of khas lands made cultivable by the project. The phrasing of the PIE questions meant that taking land by force, bribery, or being allocated land by the government would not have been recorded.

10.5.2 Land Acquisition

In this project, land (both agricultural land and homesteads) had to be acquired for the construction of the embankment, internal roads, culverts and drainage channels, and this often gave rise to social dissatisfaction. Table 10.13 shows that 20 per cent of all project households were affected and on the average 35 decimals of land were acquired from them. Unlike the other projects under the FAP 12 study, a considerable proportion of acquired land (19 decimals per affected household and 16 per cent of all acquired land reported) constituted homestead land. The reason for this may be the basin shaped topography of the project area - embankments and roads were aligned on relatively high land (such as the river banks) where the homesteads are concentrated or on the fringes of the large beels which form most of the project area. Hence the issue of loss of homesteads and resettlement may be important in some projects, depending on the settlement pattern and types of land needed for project construction.

Table 10.13 Incidence of Land Acquisition, Kolabashukhali

Category	Land Type		Total
	Homestead	Agricultural	
No. of households	10	24	34
% of household affected	6%	14%	20%
Total area acquired (dec.)	191	997	1188
Mean per HH with land acquired (dec.)	19	42	35

Source : PIE Survey

About 21 per cent of the affected households did not get compensation, which was reportedly a source of discontent about the Project. Furthermore, about 50 per cent of those who were compensated (17 out of 34 cases compensated) had to pay bribes at the average rate of Taka 15 per decimal (Table 10.14), and these were on average the larger holdings. As elsewhere, average values of compensation (Tk.150 per dec. without bribe and Tk.162 per dec. with bribe) were much less than the land prices in the locality (see the land prices quoted in Table 10.12).

Table 10.14 Payment of Compensation for Acquired Land, Kolabashukhali

Category	No. of Cases	Total land acquired (dec)	Mean Area (dec) of the plots acquired	Mean Tk/case compensated	Mean Tk/dec compensated	Mean months taken to compensate	Mean Bribe Taka/dec
Not compensated	9	342	38	0	0		
Compensated no bribe	17	221	13	1950	15	4	0
Compensated after bribe	17	629	37	5994	162	4	15
All cases	43	1192	27.7	3972	-	-	-

Source : PIE Surveys

10.6 INVESTMENT AND QUALITY OF LIFE

10.6.1 Non-land Assets

In the Kolabashukhali Project, a somewhat higher quality of housing than in the control area may reflect increased incomes due to the Project. The PIE survey shows that there were no pucca houses in the control area (Table 10.15). In this project the main difference in house types was the use of earth walls in the project, which indicates greater flood security compared with the control area. The construction of new rooms by a larger proportion of households in the impacted areas also implies higher incomes and a more secure environment for better housing in the project area (Table 10.15).

Table 10.15 Percentage of Households with different House Types, Kolabashukhali

Category	Impacted Area	Control Area
All Pucca	4	0
Pucca wall tile roof	2	0
C.I roof and wall	3	11
C.I roof wooden wall	1	5
Earth wall tile roof	15	1
Earth wall thatched roof	16	0
Thatched wall tile roof	33	37
Thatched roof and wall	26	46
Condition		
Good	13	12
Fair	43	38
Bad	44	50
Repair since project		
Major Repair	35	46
New Room	19	7
Both	2	0
None	44	46

Source : PIE Surveys

As regards non-land asset ownership (Table 10.16), farmers and fishermen's households had a slightly higher incidence of ownership of ploughs and fishing nets in the impacted area than in the control area. Notably, both project and control areas had a high ownership of boats (the highest of the PIEs). This has not changed with the project because large areas are still seasonal beels growing B. Aman, and where harvesting of both B. Aus and B. Aman takes place from boats.

Other aspects of quality of life appear little affected by the project. Most (over 90 per cent) of households had access to tubewell water for drinking before the project, although use of open water sources has declined more in the project area. However, sanitation appears not to have improved with the project. Nor did the households report any improvement in food consumption, in fact the seasonal pattern of inadequate food consumption shows a worse lean period (monsoon season) for labourers inside the project than in the control area.

Table 10.16 Incidence of Ownership of Selected Non-land Assets and Tools (% of households owing), Kolabashukhali.

Type	Farmer		Labourer		Fishermen		Others	
	Imp.	Cont.	Imp.	Cont.	Imp.	Cont.	Imp.	Cont.
Plough	60	52	-	-	26	13	17	12
Fish Net	38	36	29	29	100	80	2	38
Boat	32	34	9	1	100	87	33	31
Bicycle	26	15	-	4	7	13	22	25
HTW/MOSTI	8	12	-	-	13	-	22	19

Source : PIE Surveys

10.6.2 Credit

Kolabashukhali project has not brought about a major switch to crops requiring more purchased inputs (such as HYVs), although it does provide a more stable agricultural environment. Differences in the uptake of credit are small but suggest that more households in the project have taken credit (Table 10.17), although there is little difference in the amounts taken. Although farming households average over twice the amount of credit of non-farm households little of this goes to investment in productive activities. It is notable that a slightly higher percentage of credit is used for cultivation in the project area, suggesting some increase in use of working inputs, but much credit is still used for necessities, indicating that many households are still vulnerable to fluctuations in their fortunes.

Table 10.17 Credit use During 1990-91, Kolabashukhali

Use	Protected		Control	
	Cultivator	Non-Cultivator	Cultivator	Non-Cultivator
No. hh	120	48	60	24
% hh taking loan	43	60	38	54
Mean loan (taka/hh)	2395	1139	2942	1050
Percentage use of loans				
Cultivation	12	0	5	0
Livestock	0	0	0	0
House Repair	0	0	0	0
Necessities	86	100	90	100
Social obligation	2	0	5	0

Source : PIE Surveys

10.7 FLOOD IMPACTS

10.7.1 Incidence of Floods

The community surveys are incomplete, since little data was collected from the control area, but they show that floods were frequent before the project, while after the project there has only been one flood in most villages and 26 per cent have not suffered a damaging flood (Table 10.18). The project appears from the RRA to have been largely successful in keeping out floods, although damage may still occur due to heavy rainfall over the project area.

Table 10.18 Incidence of Floods Before and After the Project, Kolabashukhali
(No. of mouzas affected)

Incidence	Protected	Control
Pre-Project		
Every year	11(58)	1(33)
Some years	7(37)	2(67)
Rare	1(5)	-
Post-Project		
Flood	14(74)	1(100)
No flood	5(26)	-
Av. no. of flood years	1.2	-

Figures in parentheses indicate percentage of mouzas reporting given frequency.

Source : PIE Community Survey, 1991

10.7.2 Crop Damages by 1987 and 1988 Floods

In both the 1987 and 1988 floods, B. Aman and L.T. Aman, the two major monsoon rice crops, had less damage in the impacted than in the control area, but for HYV Aman (which is cultivated on relatively small acreage), B. Aus and Jute, the extent of flood damage was slightly higher in the impacted than in the control areas (Table 10.19). Hence the project appears to have reduced damage, but has by no means eliminated the problem.

10.7.3 Other Household Flood Damages

Households were asked to give details of non-crop damage in the last flood affecting the homestead area. For most, 1988 was the last severe flood, and hence the incidence of homestead flooding in 1987 is not properly known. Table 10.20 shows that a few households in the project area have experienced flooding in years since 1988, but that the project appeared to be successful in that fewer households were affected by flooding in 1988 than in the control area. Despite homestead flooding being slightly worse (deeper and for a week

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longer on average) among affected households in the project area in 1988 than in the control area, damages per affected household were higher in the control area. For the main house types in the area damages increased with depth of flooding and averaged less for thatch houses than for earthwalled or corrugated iron built houses. Over all households, the mean loss in 1988 was Tk.565 per household in the project area and Tk.959 per household in the control area. Hence, some benefits in terms of reduced non-crop flood damages have been enjoyed by the Project inhabitants, and it has been relatively successful in the most unusual flood year experienced.

Table 10.19 Percentages of Normal Yields Achieved in Kolabashukhali

Crops	1987		1988	
	Protected	Control	Protected	Control
B. Aman	36	19	24	13
L.T. Aman	48	15	44	15
HYV Aman	31	58	28	41
B. Aus	28	29	20	29
HYV Aus	81	-	74	-
Jute	20	21	24	32

Source : Community Survey of PIE, 1991

Table 10.20 Recent Damaging Floods and Non-crop Household Losses, Kolabashukhali

Criteria	Protected	Control
Percentage of households affected		
1991	1	0
1990	2	0
1989	4	2
1988	46	73
1987	0	9
1988 flood		
Mean depth (ft) in homestead	2.1	1.7
Mean duration (days)	21	14
Mean damage per affected hh (Tk)	1229	1314
% affected suffering financial loss	70	70

Source : PIE Surveys

10.8 LOCAL PARTICIPATION, OPINIONS AND SOCIAL CONFLICTS

10.8.1 Social Conflicts

According to the survey respondents, the main initiators of the project were the BWDB officials and the Union and Upazila Parishads, but there was widespread support for the project among farmers. Local committees were formed during implementation of the project but in 5 out of 19 mouzas people expressed dissatisfaction and doubts about the necessity of the project. Moreover, some 26 per cent of respondents said they had doubts about the project for such reasons as potential water logging, and four households (2 per cent) were involved in trying forcibly to prevent project works. As discussed earlier in section 10.5.2, those who were affected by land acquisition for the project but were not paid compensation were understandably the most aggrieved.

The project has given rise to a series of conflicts of interest over land use and distribution of use rights. Firstly, there is the issue of low lying lands which can be brought under cultivation but at the cost of fishermens' access to them. Secondly, whether used for fishing or agriculture there are many khals, khas jalmahals (public fishing grounds) and borrow pits in the project area which are under the control of local government (District Administration and Upazilas). The government has failed to allocate access or rights to the khas land to organised groups of poor people, such as traditional fishermen, marginal farmers or the landless. Hence, the benefits from public lands either in the same or new uses have not been distributed to target groups, despite legislation to that effect, and thus there is increased social tension with the local influentials who are able to usurp these lands and fisheries. Finally, in the southern parts of the project there are conflicts between farmers and shrimp interests: there are a few seasonal shrimp farms in the area where the management of small holdings under a shrimp farm can conflict with cultivation practices and with the landowners' choice of crops. It is also reported that the drainage/flushing sluices are opened to permit collection of shrimp larvae without considering the potential for damage to crops by the saline water admitted.

10.8.2 Opinions

According to the opinions of the protected households, the major benefits of the project are flood protection of crops (86 per cent of respondents), potential to grow an extra crop (26 per cent), flood protection of homestead (44 per cent), and improvement of the road communication system (79 per cent). Hence, the planned improvement to road communications under the project appears to be widely appreciated, and flood protection is perceived to have been successful.

The major disbenefits of the project experienced by the respondents are waterlogging (60 per cent of households), decline in soil fertility (46 per cent), reduced silt deposition (29 per cent), and loss of capture fishery (40 per cent). Small percentages reported a decline in boat transport and decline in soil moisture.

As in the other FAP 12 PIE study projects, there appears to be wide agreement between quantitative and qualitative estimates of impacts and respondents' perceptions of who benefited or disbenefited from the project. Most people regarded large landowners (86 per cent of respondents) and labourers (71 per cent) as having benefited, although 23 per cent reported businessmen as important beneficiaries. The usual groups are regarded as having lost because of the project: fishermen (49 per cent), boatmen (34 per cent) and, surprisingly, people outside the project (54 per cent). However, the latter are all within completed or ongoing polder type projects, so it is not clear if this opinion is justified.

10.9 SUMMARY

In socio-economic terms Kolabashukhali has been more positive than some of the other projects investigated by FAP 12. There has been some growth in incomes, and inequality appears not to have widened as labourers have gained. Also, flood damages appear to have been reduced. These have been direct impacts of the technical effectiveness of the project.

However, there is also a large lost opportunity to direct benefits to those who have lost (such as fishermen) or could have gained more from the project (such as redistribution of khas land to the poor). While the project has saved property and created a more productive local economy, no attention was paid to the distribution of these benefits or the social conflicts resulting from project related changes. There is much potential for a multi-agency project authority, or for involving the assistance of NGOs in promoting empowerment so that existing minority and underepresented interests are protected and benefits more widely distributed.

11 ENVIRONMENTAL EVALUATION

11.1 PRE-PROJECT SITUATION

The Barnal-Silimpur-Kolabashukhali FCD Project, referred to here for convenience as the Kolabashukhali Project, was constructed during 1979-1984. 1991 was therefore the Project's seventh monsoon season. In addition to flood control and drainage, the Project was originally planned to provide improved agricultural support services through the DAE, and an internal road system. Both of these components were subsequently largely curtailed to save costs. No specific irrigation component was included, although some of the structures were flushing sluices which allow entry of water that could be used for irrigation in early rabi. Also, a plan for pumped river irrigation near Kalia had been separately considered.

The FAO (1988) agroecological maps and reports, which cover the whole of Bangladesh, provide a reasonable overview of pre-project environmental conditions. Agroecological regions (AER) and subregions (AES) are mapped, along with soil associations. Maps and reports are based on soil surveys and related field studies during the period 1965-1977. In the Kolabashukhali area, the relevant soil surveys took place in 1977. The reports review physiography, drainage, climate, soils, water resources, land use and constraints, development potential, research needs, and ecological hazards.

Other pre-project information and trends have been derived from the discussions and in-depth interviews with local people during the RRA and environmental field visits in April-May and November 1991, and from the sources noted in Section 11.3.6.

Kolabashukhali Project forms an island of about 25000 ha. between tidal rivers of the Lower Ganges system, immediately north of Khulna city. Two-thirds of the Project area forms part of FAO's Gopalganj-Khulna Beels AER. The Low Ganges River Floodplain AER fringes this low-lying land in the north and east, and the High Ganges River Floodplain fringes it to the south. The AERs are represented by specific FAO AESs and these in turn have been equated here with FAP 12's agroecological divisions (AED), as presented in Table 11.1 and Figures 11.1 and 11.2. Table 11.1 also shows the relationships of the AEDs to soil associations mapped by FAO.

The FAO agroecological classification, therefore, provides an effective spatial framework for environmental assessment both before and after the Project. As mapped by FAO, at a scale of 1:750,000, the AESs which form the AEDs required some boundary refinement at the Project's 1:70,000 scale.

Pre-project conditions in the four agroecological divisions (AED) are discussed below:

AED A : High Ganges River Floodplain

FAO's High Ganges River Floodplain (HGRF) is represented here by the Central and Southern HGRF subregion. Within the Project Area, this comprises AED A, which is the highest land in the Project Area, occurring as river levee and some ridge and shallow trough terrain at the southern end. Khulna city has spread across the Bhairab River in one stretch, accounting for about 400 ha of high urban land which is excluded from the Project Area as defined here. AED A as mapped (Figure 11.1) accounts for only 9 per cent of the area (about 2,250 ha).

Table 11.1 Kolabashukhali: Agroecological Classification

Agroecological Region	High Ganges River Floodplain		Low Ganges River Floodplain	Gopalganj-Khulna Beels			
Agroecological Subregion	Central and Southern HGRF**		Eastern LGRF	Beel Margins		Bill Centres	
Soil Association	Gh 815	Gl 817	Gl 821* (Gl 539)	Gb 838	Gl 840	Gb 842	Gb 543
Approx % of Area	7	2	23	3	37.5	17.5	10
Land Types (Flooding - cm.)	%	%	%	%	%	%	%
Settlements	10	10	5	5	4	2	2
H (0)	15	10	5	8	0	0	0
MH1 (0-30)	2.5	17	4	6	21	1	0.5
MH2 (30-90)	27.5	36	31	16	0	1	9.5
ML (90-180)	45	22	55	65	60	61	55
L (180-300)	0	5	0	0	15	35	33
VL (300+)	0	0	0	0	0	0	0
Total	100	100	100	100	100	100	100
Agroecological Division: FAP 12	A		B	C		D	
Approx. % of the Area	9		23	40.5		27.5	

Source: FAO, 1988 and Consultants.

Note: * Includes Gl 539 as originally mapped.
** Excludes urban extension of Khulna from the Project Area.

Most of AED A consists of Soil Association Gh 815 (Table 11.1) but the narrow strip of river levee along the Atharabanki River, mapped by FAO as Soil Association GL 817 within the LGRF, has also been included because of its similarity to the Bhairab river levee. Thus AED A has considerable Highland and Medium Highland, with Medium Lowland found mainly in the small, shallow basins of Soil Association Gh 815. As Figure 11.2 shows, the levees and ridges occupy over half the landscape. Even so, pre-project flooding occurred regularly in the small basins and at times could be severe. The higher land was also affected when heavy rainfall coincided with high tides and/or high river discharge. Annual rainfall averages 1,700 mm in the Project Area.

The soils are classified by FAO (1988) as Calcareous Dark Grey or Brown Floodplain Soils. The brown soils occur on the levees and ridges as calcareous silt loams and silty clay loams, changing downslope to silty clay loams and clays, which may be noncalcareous in the upper soil. The pH is about 6.0 (topsoil) and 7.0 (subsoil) on the ridges and slightly lower in the basins.

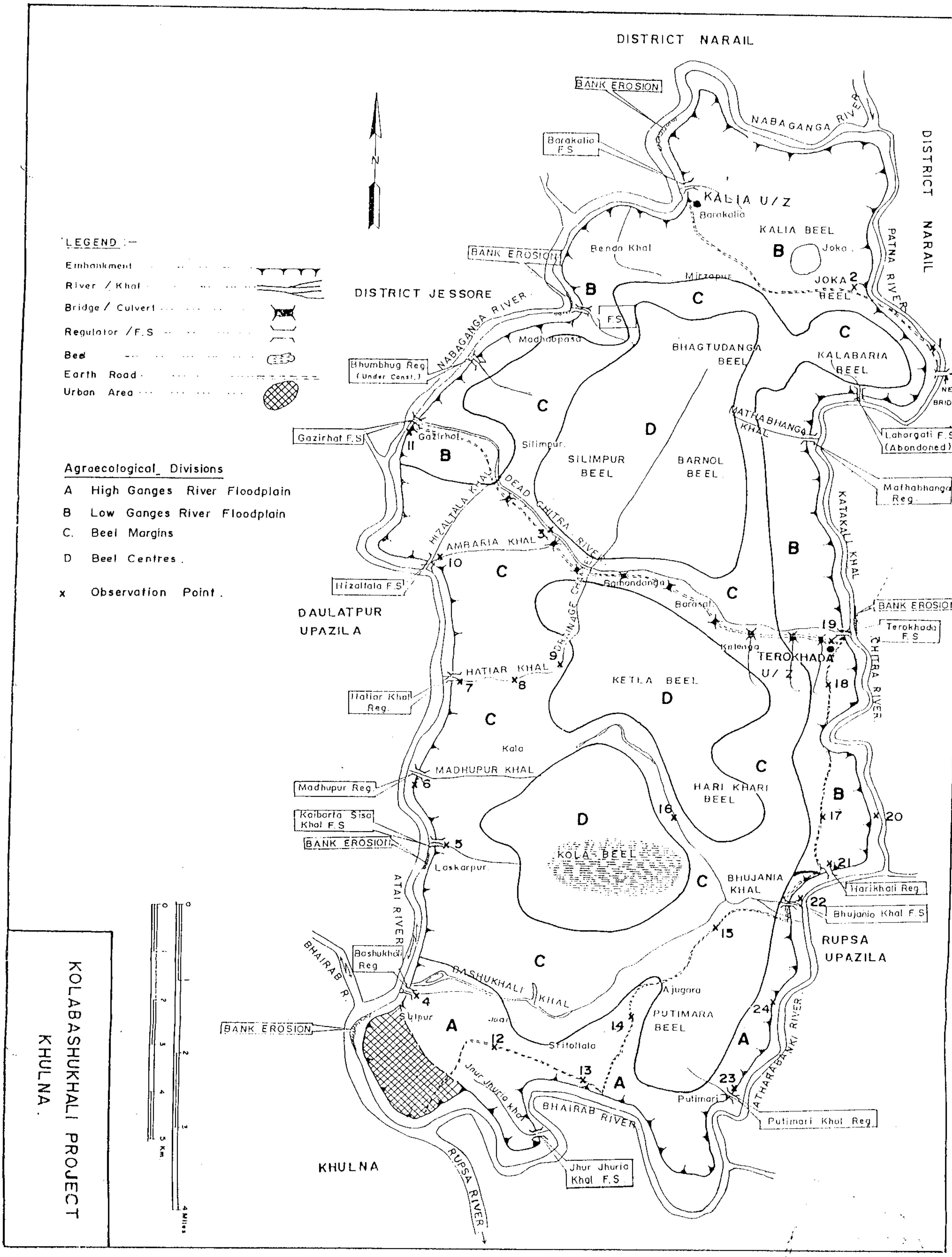
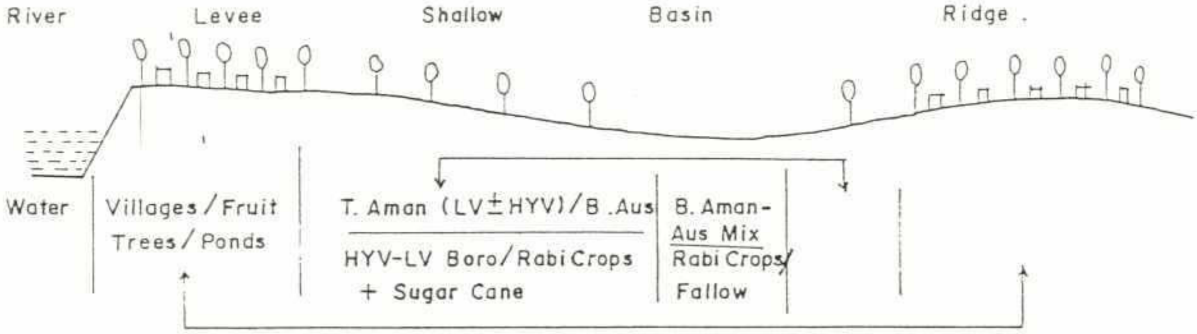


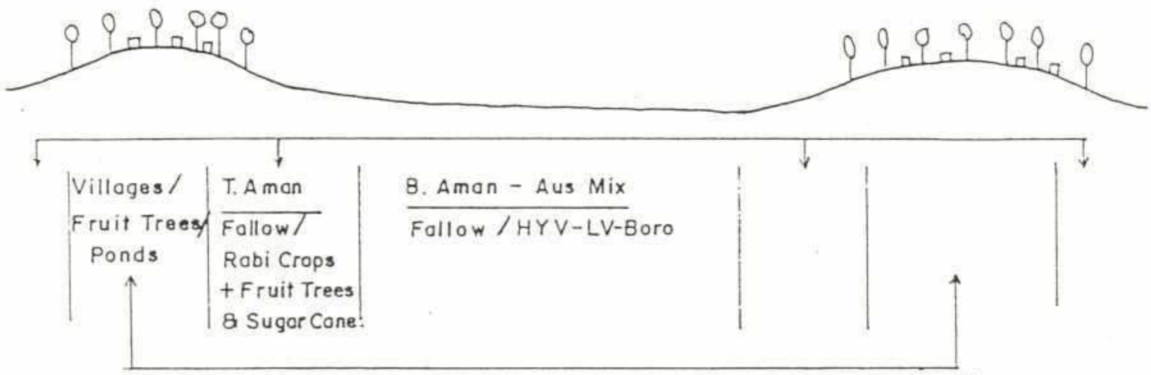
Figure 11.1 Agroecological Divisions and Observation Points

Figure 11.2 Kolabashukhali Agroecological Divisions (AED)

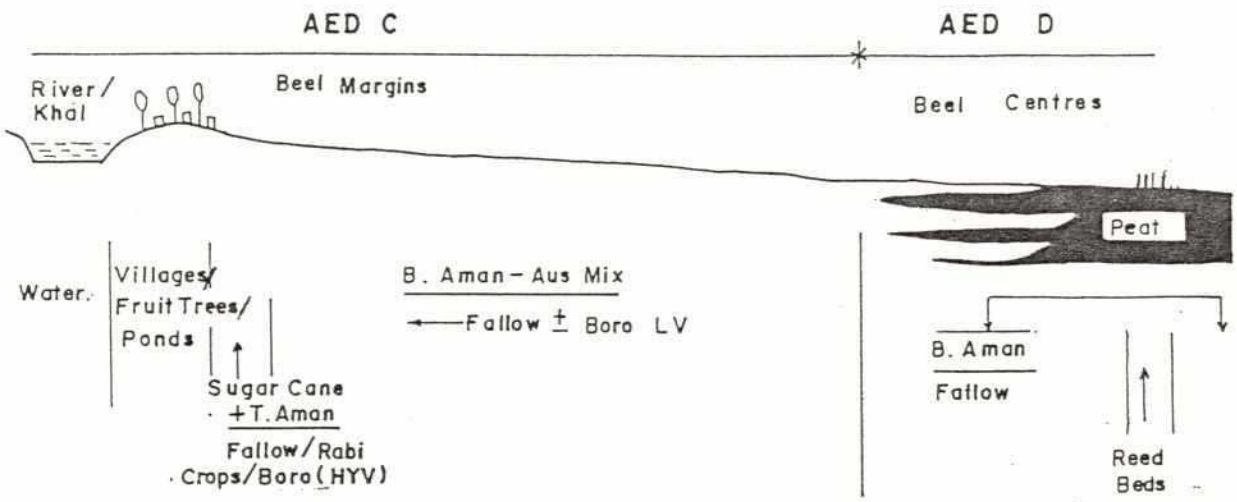
AED A : High Ganges River Floodplain



AED B : Low Ganges River Floodplain



AEDs C and D : Gopalganj — Khulna Beels.



Pre-project land use was variable in AED A, reflecting the variations in flooding depth (Table 11.1). Villages, with trees, vegetable plots and ponds, occupied the highest parts of the ridges. On the adjacent levee and ridge slopes, the main kharif crops were B. Aus followed by or mixed with B. Aman, or by T. Aman LV on the higher parts. Some jute was also grown. Rabi crops included mustard, sesame, pulses and vegetables, which could be grown before the rivers became saline and/or utilising residual moisture. The small basins were planted to B. Aman and largely left fallow in rabi.

A problem in AED A, as in most of Kolabashukhali, was the increasingly early incursion of saline tidal water upstream along the flanking rivers. This was blamed on the Farakka Barrage on the Ganges in India, especially after the breakdown of the treaty on water allocation in 1978. It is claimed that water entering the Project Area on the tides was too saline for cultivation well before the end of the rabi season, thus preventing Boro and other rabi crops in the lower, basin areas. Tubewell irrigation was precluded by the belief that the groundwater is saline under the skim of fresher water sometimes used for domestic water supply.

AED B: Low Ganges River Floodplain

AED B occupies the north of the Project Area and a belt of land flanking the Katakali and Chitra Rivers, covering about 23 per cent (5,750 ha). It is part of the Central LGRF AES defined by FAO. AED B consists of lower and narrower ridges than in AED A, separated by troughs that are rather wider and flat-bottomed. As a result, the proportion of H land is very low and ML land is more extensive. However, compared to the rest of the Project Area, AED B is relatively elevated land.

Flooding was consequently somewhat more pronounced in pre-project times, although a position further upstream reduced the impact of increasing and earlier penetration of tidal water. AED B continued to receive adequately fresh water throughout most of the rabi season.

The soils are similar to these in AED A, but with a larger proportion of basin soils. The pre-project cropping pattern was also similar, although with B. Aman more extensive and T. Aman LV only occasionally grown. In several places in the north the non-saline river water in rabi was used for small-scale Boro LV cultivation, notably around Benda Khal. Some exploitation of shallow groundwater was beginning to take place, but as noted the deeper groundwater is thought to be saline.

AED C: Beel Margins

Two thirds of the Project Area is occupied by extensive low-lying land which in pre-project times was flooded to considerable depth by monsoon rains, high river discharges and the barrier effect of high tides. These tidal beels are particularly extensive around Khulna and Gopalganj, with Kolabashukhali providing several good examples.

AED C represents the broad margins of the beels, where flooding was less excessively deep and also seasonal. In places, narrow strips of slightly elevated land developed along the river or the tidal khals which penetrated the beels. These probably consist of made land as much as natural alluvial mini-levees. Settlement, trees, tracks, and ponds were concentrated along these distinctive linear features.

AED C covers 40.5 per cent of the Project Area (just over 10,000 ha), dominated by ML land, with L land downslope. MH land occurs on the levee strips, with even occasional H land along the main rivers. The dominant soils are poorly drained, acidic clays (Noncalcareous Dark Grey or Grey Floodplain Soils - FAO, 1988) which upslope grade into less acidic silty clays and silty clay loams (FAO's Calcareous Dark Grey Floodplain Soils). Limited tracts of brown, loamy soils may occur by the main rivers (but post-project mostly outside the embankments).

Some B. Aus-B. Aman mix was possible pre-project on the highest lands near rivers and khals, but almost all AED C attempted B. Aman. The degree of success varied from year to year and from place to place, depending on the floods. Cultivation, therefore, was subject to considerable uncertainly and wasted effort. Inputs, understandably, were kept to a minimum. There was little scope for rabi cropping, as the seasonal flooding was prolonged well into the rabi season, with saline water still entering the area on high tides later in the season. Use for grazing seems to have been limited, presumably due to the prolonged flooding.

AED D: Beel Centres

There are three major tracts of particularly low land: Kola Beel, Ketla Beel and the combined Silimpur-Barnal Beels. They cover 27.5 per cent of the Project Area (nearly 7,000 ha.).

These lands flooded very deeply in the monsoon in pre-project times and remained wet throughout the year. FAO's ML and L land units (Table 11.1) occupy virtually all of AED D. Over three-quarters of the land consists of peat, which in the surrounding remainder is thinly overlain by acidic, heavy clays.

Some attempts at B. Aman cultivation were made on these peripheral soils pre-project but mostly AED D was occupied by extensive reed-beds which were cut annually for thatching or by open water. Fishing was an important occupation.

11.2 PROJECT OBJECTIVES

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

11.3 APPROACH AND SOURCES OF INFORMATION

11.3.1 Preliminary Environmental Post-evaluation (PEP)

Preliminary environmental post-evaluation (PEP) has been defined here as the post-evaluation equivalent of environmental appraisal (ODA) or initial environmental examination

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

The PEP approach proceeds beyond the screening-scoping activities of the initial RRA and is the environmental element of the PIE. In particular, more detailed and controlled information is acquired locally by systematic and structured interviews and multiple visits conducted by the FAP 12 PIE teams, while the environmental field observations and interviews are more intensive along carefully selected transects (Figure 11.1). The selection of transects is important because the PEP attempts to evaluate environmental impacts in terms of the different agroecological divisions, so that the transects must cross a representative selection of these, enabling contrasts and interrelationships to become apparent.

The PEP adopts different time and spatial perspectives to those of the PIE socio-economic surveys. The latter compare the Project area with a purposely selected control area (see Section 11.3.5) for a specific crop year (Aus 1990 to Boro 1990/91). This permits comparison of with- and without-project scenarios. The PEP, on the other hand, retains the before-and-after approach of the RRA studies, thus confining itself to the Project Area and any external impact areas (Section 11.3.3) 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 may miss. In addition, the PEP covers the ecological (i.e. physical and biotic) impacts of the Project, as well as the human (largely socio-economic) impacts covered by the PIE surveys. The PEP takes advantage of the much more detailed level of the PIE findings with regard to human environmental issues. As the above comments show, however, the different temporal and spatial perspectives of the PEP and PIE surveys mean that their conclusions are not meant to be identical, but rather to complement each other.

11.3.2 Agroecological Divisions

The agroecological divisions used within the Project Area are the four AEDs defined in Section 11.1, with external (off-site) impact areas defined below in Section 11.3.3. The application of the AEDs requires clarification. Agroecological divisions are dynamic, changing especially in response to human influence. In the case of AED D it could be argued that its extent has been greatly reduced by the considerable incursion of agricultural activity since the Project. However, it is considered here that the major ecological differences caused by the peat soils are the primary criteria, so that AED D remains unchanged in extent, although greatly impacted.

11.3.3 External Areas

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

The external areas affected by Kolabashukhali FCD Project are grouped here under three headings:

- Western Riverine Areas (WRA);
- Eastern Riverine Areas (ERA);
- Downstream Areas (DSA).

The Western Riverine Areas (WRA) include the courses and adjacent lands outside the embankment along the Nabaganga, Atrai and (west of the Rupsa confluence) Bhairab Rivers. Setback on the rivers' left banks is often very narrow and rarely more than a few hundred metres. The urban excluded area is too high to require embanking. Across the rivers, embankments protect the areas to the west. The available land on both sides is densely settled, with the remainder largely cultivated. The rivers are large and natural bank erosion is widespread. Tidal saline incursion penetrates north of Gazirhat by March, as discharges reach a minimum.

The Eastern Riverine Area (ERA) is along mostly smaller rivers (Patna, Katakali and Chitra), with the Atharabanki and Bhairab (east of the Rupsa confluence) more comparable with the WRA rivers. Setback on the right banks is usually 100-200 metres of densely settled or cultivated land along the smaller rivers, but further south along the Atharabanki and Bhairab there are some wider stretches, although often occupied by wetlands supporting dense reed (Typha sp.) vegetation. These reeds are systematically cut for roofing and walls. On the left banks most of the land forms the control area (Section 11.3.4), Bhuter Beel, where embankments are incomplete and afford little protection.

The Downstream Area (DSA) consists of the Ganges Tidal Floodplain (FAO, 1988), which includes Bangladesh's ecologically most intact and important area, the Sundarbans mangrove forests. The DSA has low relief even compared to the Project Area and is a maze of tidal rivers and creeks.

11.3.4 Control Area

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

The control area is of less value for the physical and biological assessments because it is ecologically not comparable with Kolabashukhali. This is because Bhuter Beel consists wholly of FAO's Low Ganges River Floodplain, which accounts for only 23 per cent of Kolabashukhali. It is therefore ecologically comparable mainly with the north of the Project Area and a narrow adjoining strip on the east (AED B). Bhuter Beel lacks the distinctive large peat beels which are such an important ecological feature of Kolabashukhali.

11.3.5 Identification and Assessment of Environmental Impacts

It is clearly important that the environmental evaluation assesses project impacts relative to what would have been the continuing pre-project trends, rather than to specific points in time. In Kolabashukhali, however, the trend of increasing population pressure was less marked than in most other FAP 12 study areas. The difficulties of settlement and cultivation in the perennially flooded beels prevented this. Excess population growth was readily attracted to the adjacent or nearby major cities such as Khulna and Jessore.

Two other important trends elsewhere, the development of tubewell irrigation and the spread of HYV paddy varieties, are not of great importance in KBK.

It is necessary to assess also the impact of what the Project has achieved in practice, rather than the anticipated impact of what was planned. Drainage has not been as effective as intended due to poor planning and design of structures, followed by poor operation and maintenance, especially the limited excavation of khals.

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, 1991b).

11.3.6 Sources of Information

The main existing sources of information have been the Feasibility Study by DSP (177) and the FAO (1989) Project Completion Report. Other sources include the undated Project Proforma by BWDB and a socio-economic project evaluation by ESL (1986). Apart from FAO's rather conservative estimate for fishery losses, none of these took account of the disbenefits to fishing, livestock, and boat transport.

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.

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

11.4 PHYSICAL ENVIRONMENTAL IMPACTS

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

11.4.1 Physical Impacts (Water)

a) River Flow

There are no active rivers within the Project Area. Khals and the dead Chitra River, which bisects the Project Area between Gazirhat and Terokhada, are considered with wetlands and waterbodies in (g) and (h) below.

The main river flow parameters of discharge, velocity, timing, rate of rise and duration are complicated in Kolabashukhali by the strong tidal influence. With regard to external impacts of the Project, all river-related issues are considered to be affected by the cumulative impact of all FCD projects within the Lower Ganges system. This is essential to give a realistic assessment of spatially cumulative impacts which might otherwise be underestimated.

Table 11.2 Physical Environmental Impacts.

Physical Issues	Environmental Impact								
	Project Area (AEDs)					External Areas			
	A	B	C	D	Overall	WRA	ERA	DSA	Overall
WATER									
a. River Flow	-	-	-	-	-	-2	-2	+1?	0
b. River Quality	-	-	-	-	-	+1	+1	+1?	+1
c. River Morphology	-	-	-	-	-	-1	0	+1?	0
d. Flooding and Drainage	+1	+1	+2	+3	+2	-2	-2	0	-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. Wetlands and Waterbodies Extent/Recharge	0	-1	-2	-3	-3	0	0	+1?	+1?
h. Wetlands and Waterbodies Quality	0	0	-1	0	0	0	0	+1?	+1?
i. Marine Siltation/Salinity	-	-	-	-	-	-	-	0	0
LAND									
a. Soil Fertility	0	-1	-1	-2	-2	0	0	0	0
b. Soil Physical Characteristics	0	0	0	+2	+1	0	0	0	0
c. Soil Moisture Status	0	+1	+2	+3	+3	-1	-1	0	-1
d. Soil Erosion	0	0	0	-1	-1	0	0	0	0
e. Soil Salinity	+1	+1	+1	0	+1	0	0	0	0
f. Acid Sulphate Status	0	0	0	0?	0?	0	0	0	0
g. Microrelief	0	0	0	-1	-1	0	0	0	0
h. Land Capability	+1	+1	+2	+1?	+2	-1	-1	+1?	0
i. Land Availability	0	+1	+1	+3	+3	0	0	0	0

Source: Consultants

Note: ? uncertain impact.

Thus both up-river and down-river flows (at high and low tides respectively) have been increased by the embankments of projects containing them. A moderate negative impact therefore occurs in both the WRA and ERA.

In the DSA it seems likely that on balance extra fresh water reaches the tidal flats, due to the containment upstream. This is cumulatively a minor positive impact, because it counterbalances the decrease in river flow caused by Farakka and other major diversions in India. However, such a conclusion requires confirmation by modelling and quantification.

The conflicting impacts between the riverine and Tidal Floodplain external areas gives an uninformative balanced rating overall, due to the latter's much greater extent and importance.

b) River Quality

Potential key quality factors are sewage, agrochemicals, sediment load and salinity.

In the WRA and ERA there is no significant negative impact. Drainage effluent from the Project Area at low flows/tides is unlikely to contain much added pollution caused by the Project. There has been only a limited swing to HYV crops, so that agrochemical use has not risen sufficiently to create a problem. Sanitary awareness and latrine usage seem to have increased in recent years. The Project does not increase sediment or salinity.

The Project does not contribute to upriver tidal incursion; in fact, it helps to resist this by containing more freshwater in the riverine areas. This constitutes a cumulative minor positive impact on river quality.

The DSA undoubtedly receives some very polluted water below the Project Area but this is due not to the Project but to the major industrial and urban concentrations along the Bhairab River, especially Khulna itself. The busy river traffic, including many large vessels, contributes further to this. The Project, on the other hand, probably has a minor positive impact on DSA water quality, by helping to dilute both saline tidal water and this pollution, countering the loss of dilution caused mainly by diversions in India.

c) River Morphology

River morphology parameters are bank erosion, bed scour and siltation. It seems likely that the increased flows contributed by the Kolabashukhali and related projects are causing bank erosion additional to the natural river activity, which is considerable in the WRA particularly, where rivers are larger and more powerful. The added flows may also increase scouring, while dry season low flows might deposit more silt. A net minor negative impact is assessed in the WRA. The impact is less in the ERA and is considered insignificant from observations there.

In the DSA one outcome must be greater silt deposition than without the projects, as the Tidal Floodplain receives silt that previously accumulated within areas now protected. Scouring and bank erosion are unlikely to be significantly affected. On balance, the DSA siltation is taken as a minor positive impact, as ultimately it will create new land for Bangladesh. However, this is an uncertain impact, so that the overall external impact is balanced.

d) Flooding and Drainage

The Project was designed to provide flood control and drainage and so to have a comprehensive beneficial effect on the level, timing, rate of rise, duration and extent of flooding. Control of river and tidal flooding has largely been achieved. However, rainfall flooding still occurs and drainage is often inadequate in removing it, especially in really wet years such as 1987 and 1988. In those years particularly there were public cuts in the embankment to release flood waters.

AEDs A and B have benefitted from flood protection of their basin areas and improved natural drainage of their ridges as a result. However, in the dry season the latter effect creates an adverse impact by drying the land too quickly. A net minor positive impact is assessed for both AEDs.

There has been a net moderate positive impact in AED C. Flood levels have been substantially reduced. This is balanced, however, by the drainage congestion caused where drainage lines such as Bhujania Khal and the sluices on them are incapable of releasing effluent sufficiently quickly.

In AED D the impact on flooding has been a major one. Perennial flooding has been reduced to a few small patches and the overall depth and rapidity of flooding are much less.

The overall Project Area impact is moderate positive.

In the external riverine areas (WRA and ERA), flooding has been substantially increased by the cumulative effects of Kolabashukhali and related projects. Moderate negative impacts are recorded. In the DSA the impact is negligible when set against the decrease due to Indian diversions and the strong tidal influences.

e) Ground Water Levels/Recharge

This is not an important issue because there seems only limited scope for groundwater exploitation. Also, groundwater recharge is influenced by both the adjoining rivers and especially the sea. The negligible elevation above sea level of most of the Project Area means that it can exercise little influence over groundwater levels. No significant impacts are assessed in either project or external areas.

f) Groundwater Quality

The limited increase in agrochemical use and indiscriminate sewage noted in (c) above seem to make these forms of pollution unimportant. However, the reduced direct recharge of monsoon river water to the watertable may cause groundwater within the Project Area to become even more saline. At present this is not assessed as a significant impact, but it requires monitoring to confirm or change the assessment.

Lack of data makes the whole question of current groundwater quality and future trends difficult to judge. A clearer idea of groundwater potential for irrigation in areas such as Kolabashukhali is urgently needed, now that so much land is potentially available for it.

g) Wetlands and Waterbodies Extent/Recharge

Clearly the Project has had an overall major negative effect on the extent of wetlands, with the perennial swamps of the peat lands (AED D) virtually gone and the seasonal swamp tracts in the Beel Margins (AED C) largely replaced by cultivation. AED A had no important wetlands and so has not been significantly affected. In the occasional small seasonal beels in AED B, such as Kalia and Joka Beels, the impact is only minor.

There is no wetland in the riverine areas, although wetlands in Bhuter Beel may have benefitted from the extra flooding caused there. Wetlands in the Ganges Tidal Floodplain, notably the Sundarbans, will have received a minor positive impact, as noted in (a) and (c) above.

h) Wetlands and Waterbodies Quality

The discussion in (c) above indicates that wetlands quality is unlikely to be significantly affected by the Project. A weak minor negative effect occurs in AED C, where most of the main khals and the dead Chitra River are found. Quality in these has suffered from stagnant conditions induced by drainage congestion, so that in many villages they can no longer be used as a source of domestic water.

Wetlands quality in the DSA external area can be seen from (c) above to have possibly received a minor positive impact. The extent of the DSA and importance to have received a minor positive impact. The extent of the DSA and importance of the Sundarbans give a similar weighted overall impact.

i) Marine Siltation/Salinity

The only impact area to include marine waters is the DSA. However, despite the minor impacts on the Ganges Tidal Floodplain, it is not thought that the additional silt and freshwater is sufficient to affect marine siltation or salinity significantly.

11.4.2 Physical Impacts (Land)

a) Soil Fertility

Soil fertility has been reduced in AEDs C and D by the considerable retraction in land flooded for very long periods. Flooded land supports aquatic vegetation on which the blue-green algae and other organisms flourish which provide soil nitrogen. Rotting of this organic matter also contributed to soil fertility. However, as B. Aman cultivation keeps the soil wet into the dry season and encourages aquatic vegetation and is still by far the dominant land use in AED C, the impact is not very significant. Similarly, AED D is occupied by either natural reed-beds or incursions of B. Aman, and still flooded for much of the year; in addition, organic content is already very high in the peat soils.

The exclusion of river sediments also reduces fertility, especially in AEDs C and D, because both the sediments and the water bearing them are calcareous. They therefore help to counter the generally marked soil acidity. In AED D in particular, the sediments would also have been valuable additions to form mineral topsoils over the peat.

What is significant in AED D, also, is that the greatly extended cultivation of the peat soils and their exposure to drying-out each year will initiate their slow destruction. In addition, as they dry they will become extremely acidic and will require substantial amendments.

Net impacts on both AEDs C and D are assessed as at least moderate negative impacts.

In AED B basin soils, the reduced flooding and switch from B. Aman to T. Aman create a minor negative impact on soil fertility.

Impact on soil fertility is unlikely to be so significant in AED A where basin soils are of limited extent, or in the external areas.

Soil fertility is a particularly important issue in Kolabashukhali, because of the minimal use of artificial fertilisers in B. Aman and Aus/Aman cultivation in AEDs C and D and the generally acid soils. A weighted overall moderate negative impact is assessed.

b) Soil Physical Characteristics

The exclusion of sandy river deposits from AED C is too localised to be significant. The loss of slow topsoil build-up by seasonal river flooding in AED D is more general within the division but is more than countered by the marked improvement in the physical characteristics of the peaty soil, in particular the bearing capacity. In some areas pre-project cultivation had to be carried out by throwing seed into the land from a boat, because of the low bearing capacity. Even after the Project most harvesting in AED D can be done only by boat.

AEDs A and B and the external areas are not significantly affected.

c) Soil Moisture Status

Net impact of improved drainage of basins and over-drying of ridge soils in AED A is about balanced, and slightly positive in AED B, with its larger basins. In AED C the improvement has been in reduced depth and rate of seasonal flooding, rather than extent of wet soil, so that impact is significant mainly in terms of duration. A lot more AED C land could support rabi season cultivation if irrigation were available. This represents a moderate positive impact on soil moisture status. The even more dramatic change in AED D is a major impact, with perennial wetness now removed.

The riverine external areas suffer slightly wetter soils due to the additional flooding. In the DSA tidal influences on soil moisture status overshadow any project effects.

d) Soil Erosion

This is an issue of negligible importance everywhere except in AED D. Elsewhere, only the embankment suffers any soil erosion and this is not great; also, the area occupied by the bund is a very small proportion overall.

In AED D there is a potential problem of wind erosion of peat in the dry season following its exposure, cultivation and drying out. A minor negative impact is assessed.

e) Soil Salinity

In pre-project conditions, soil salinity in the basins of AEDs A and B and in AED C was raised temporarily (but sometimes critically) by the incursion of saline tidal water. This problem is now largely avoided, although leaking or badly operated structures create localised difficulties. A minor positive impact can be assumed throughout the Project Area, as the high rainfall and freshwater flushing prevented this becoming a major long-term problem.

The incidence of this problem in the riverine areas has not changed significantly. In the DSA, tidal influences are dominant.

f) Acid Sulphate Soils

It is possible (FAO, 1988) that patches of acid sulphate soils occur amongst the peats of AED D. No impact can be assigned until it is known if significant extent do occur. If so, drying out of these soils would create excessively acidic conditions which it would not be feasible to amend at present levels of farming.

g) Microrelief

Again, only AED D is likely to be significantly affected. Once cultivated and seasonally dried, peat is subject to subsidence caused by shrinkage and wind erosion. This will create uneven surface microrelief. Given re-wetting in the monsoon, it is likely to be only a minor negative impact.

h) Land Capability

Clearly there has been a marked improvement in land capability in the basins of AEDs A and B. Increased dry-season droughtiness on the ridges partly negates this but in AED B especially the larger proportion of basin land means a slight net positive impact. In AED A this is weaker but still significant. Even in AED C increased dry-season dryness has in a few places prevented Boro LV cultivation continuing, but the net positive impact in reducing flood levels, rates of rise and duration far outweighs this effect to give a moderate positive impact.

AED D impact is less easy to evaluate. The land has become capable of cultivation but its suitability in this respect requires more sophisticated levels of farming than those available. It is arguable that AED D is more suitable for fishing than for cultivation, given local levels of technology. Interpreting land capability here in terms of land suitability, only a minor (and uncertain) positive impact is assessed.

Land capability in the riverine areas is slightly diminished by the cumulative increase in flooding. In the DSA the minor beneficial impact on river quality (Section 11.4.2 (b)) is reflected, although weak.

i) Land Availability

This remains largely unchanged in AED A. In AEDs B and C, small seasonal beels such as Kalia and Putimara Beels have been diminished, creating newly available land. Generally, the improvement in AED C has been in capability rather than increased extent. In AED D, on the other hand, almost the whole area has been made available, a major positive impact from a land availability viewpoint. The weighted overall impact in the Project Area is also taken as major positive.

Land availability has not been affected in the external areas.

11.5 BIOLOGICAL ENVIRONMENTAL IMPACTS

In most of the FAP 12 study areas it has been seen that background trends such as population pressure and consequent increased cultivated extent and settlement have generally far outweighed the biological impacts of FCD projects and in most cases pre-dated them.

This is much less the case in Kolabashukhali, where so much of the Project Area was previously unavailable for cultivation and could only support a fairly constant population. Excess population was readily absorbed in adjacent urban/industrial areas, notably Khulna. It is significant that Khulna city effectively extends into the south of the area (Figure 11.1).

Even so, the local people did exploit the wetlands to some extent pre-project, by building protective bunds, cutting reeds, fishing, hunting, and sporadic broadcast rice cultivation. Undoubtedly the extent of wetlands and their biotic communities were already reduced to well below "natural" levels. In addition, one background trend (fish disease) has been important post-project, since about 1988.

Table 11.3 summarises the biotic environmental impacts attributable to the Project, which are more marked than in most of the other FAP 12 PIEs.

Table 11.3 Biological Environmental Issues

Biological Issues	Environmental Impact								
	Project Area (AEDs)					External Areas			
	A	B	C	D	Overall	WRA	ERA	DSA	Overall
FAUNA									
a. Bird Communities/Habitats	0	0	-1	-2	-2	0	0	+1	0
b. Fish Communities/Habitats	0	0	-2	-3	-3	-1	-1	0	-1
c. Other Macro-fauna Communities/Habitats	+1	+1	-1	-1	0	+1	+1	+1	+1
d. Micro-fauna Communities/Habitats	0	-1	-1	-2	-2	0	0	+1	0
FLORA									
a. Trees	0	0	0	0	0	0	0	0	0
b. Other Terrestrial Vegetation	0	0	0	0	0	0	0	0	0
c. Aquatic Vegetation	0	0	-1	-2	-2	0	0	0	0
d. Mangroves	-	-	-	-	-	-	-	+1	+1
e. Marine Vegetation	-	-	-	-	-	-	-	0	0

Source: Consultants

11.5.1 Biological Impacts (Fauna)

A basic problem in evaluating the impacts of the Project on all fauna considered in Section 11.5.1 is the total lack of any data from any previous point in time. There is a general claim by local people that at some ill-defined time in the past, birds, fish and other wildlife flourished in large numbers, but no quantified baselines exist, either now or in the past. The only broad numerical data relate to fish catches and are of doubtful reliability. In any case, they effectively show what fishermen wished or were able to catch at the time in question. Thus all assessments in this Section are based on inference and hearsay, regarding the pre-project situation.

a) Bird Communities/Habitats

It is reported that bird populations were much greater "ten years ago", especially during the winter migratory period. This statement is heard everywhere in Bangladesh, even in areas where it is obvious that old wetlands have been paddy fields surrounded by villages for several decades. However, in Kolabashukhali it is quite likely to be more accurate.

In pre-project times the wetlands of AED D in particular would have been an ideal habitat for many types of fauna, especially birds, frogs and fishes. Population pressure was less than in many areas and wildlife exploitation would not have been easy in such large, perennial beels. It is said that in "bad years: (i.e. major flood years such as 1987 and 1988) the birds return, presumably as the land reverts to swamp and reeds.

A moderate negative impact is inferred, with a minor impact in the sporadic small beels in AED C. AEDs A and B and the riverine areas are not significantly affected. A weak minor positive impact is assessed in the DSA, given the assumed small positive cumulative effect of this and related projects on ecological conditions there, and especially in the Sundarbans.

b) Fish Communities/Habitats

Clearly there must be a general negative impact on fish ecology due to the reduction of perennially and seasonally flooded areas and depths and to the interruption of spawning and recruitment for the major species, especially the carps (see Chapter 7). This does not significantly affect AEDs A and B, but is a moderate negative impact in the seasonal beels and flooded lands of AED C and a major impact in the main, once perennial beels of AED D. Already, two major fish species are claimed to be "extinct" in the area.

These impacts are assessed relative to the acknowledged background trends in fish population decline caused by increased and more ingenious fishing and, in the last three years, by the nationwide incidence of fish disease. A critical consideration is that whatever the direct effect on fish populations, their habitats have been substantially diminished or destroyed. Chapter 7 provides detail on this serious impact.

In the riverine areas, the cumulative negative impact of FCD projects in the Lower Ganges system, set against the general trends induced by overfishing and disease, are assessed as minor. They relate mainly to interruption of breeding. In the DSA tidal influences outweigh any project impacts.

c) Other Macro-fauna Communities/Habitats

Other macro-fauna, which would have occupied all parts of the area in the distant past, have long ago been largely reduced to insignificant numbers and any dry land habitats totally destroyed. The Project, however, has had some positive impact on species such as rats and possibly snakes, which are said to have multiplied, taking advantage of the embankments and other areas now of assured freedom from flooding. Certain wetland macro-fauna, such as frogs, will have suffered, so a minor impact is registered in AEDs C and D. The net overall impact seems about balanced.

The riverine areas, along which the embankments are located have seen the same increase in rat and possibly snake populations. A similar weak minor positive impact is assessed in the DSA, caused by the cumulative positive effect of FCD projects there.

d) Micro-fauna Communities/Habitats

This issue relates to the discussion in Section 11.4.2 (a), where a reduction in blue-green algae and other micro-organisms is inferred, due to the reduced flooding. This negative effect is negligible in AED A and only slight in AED B and also in AED C (which remains under prolonged flooding for B. Aman cultivation). A more substantial change has occurred in AED D, where perennial flooding has been greatly reduced.

The riverine areas are not significantly affected. A weak minor positive impact in the DSA is attributed to the cumulative effect of Lower Ganges FCD projects on the ecology of the Tidal Floodplain, again emphasising the Sundarbans micro-biota.

11.5.2 Biological Impacts (Flora)

a) Trees

Tree populations in the area are negligible except around settlements, where they have not been significantly influenced by the Project, although in a few places trees have been planted on the embankment (mainly fruit species such as banana). External areas are not affected.

b) Other Terrestrial Vegetation

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

c) Aquatic Vegetation

The communities and habitats of the aquatic vegetation were concentrated in the wetlands and waterbodies pre-project. A slight negative impact occurs in AED C due to shortened flooding and beel reduction, but it is in AED D that the major impact is found. There the reed-beds have largely disappeared.

No real effects occur in the off-site areas, except as discussed below in (d).

d) Mangroves

The ecological importance of the Sundarban mangrove forests is such that they require separate consideration. It is assumed here that the combined cumulative influence of Lower Ganges FCD projects in funnelling freshwater into the Tidal Floodplain must to a minor degree counter the widely-acknowledged negative impact of the major Indian diversions of the Ganges on the Sundarbans. It would be interesting to attempt to quantify this. Here a slight positive impact is assessed.

e) Marine Vegetation

This is noted for completeness. It is not felt that the Project has any significant impact on sea grass, seaweeds, and other marine vegetation.

11.6 HUMAN ENVIRONMENTAL IMPACTS

Some of the most important environmental impacts of the Kolabashukhali FCD Project are those affecting the human environment. However, many of these are covered in other chapters of this report. Here they are presented in Table 11.4 and are in most cases only briefly summarised below. They can be conveniently grouped into five sub-categories; human use, social, economic, institutional and cultural. Consideration of human impacts in terms of the different AEDs and external areas adds a distributional perspective to the more detailed discussions elsewhere in the report.

11.6.1 Human Use Impacts

a) Crop Cultivation

Chapter 5 considers the overall project impacts on cultivation, including irrigation, in detail. Figure 11.2 shows present land use in the different AEDs.

There has, in fact, been little irrigation development. The difficulty is that while the flushing sluices can provide water for the first half of the rabi season, the river water becomes increasingly unsuitable due to salinity. This results from tidal incursions upstream until by February-March, only the north of the Project Area can get acceptable irrigation water. In places in AEDs A and B it has been possible to supply irrigation in late rabi from a few shallow tubewells. Against this, the more complete drying up of the low-lying soils in these AEDs and in AED C has in places stopped pre-project Boro LV cultivation.

Since pre-project background trends in cultivation were more or less static, most of the improved output post-project can be attributed to the Project. There has been a minor positive impact in AEDs A and B due to increased crop security in both the monsoon and pre-monsoon seasons. This has been accompanied by: a switch from B. Aman to T. Aman LV; a less marked switch to HYV from LV T. Aman; and increased sugar cane cultivation. HYV or LV Boro occurs in areas where irrigation is feasible, but the increase due to the Project has been small.

A similar trend has occurred on the narrow levee strips in AED C but of far greater significance has been the general improvement there in crop security in relation to B. Aman.

The highly uncertain pre-project B. Aman crop has been largely replaced by B. Aus/Aman, especially on the upslope parts. Rabi cultivation remains difficult, as flooding is still prolonged into the dry season and the B. Aman harvest is still largely conducted by boat. Boro LV cultivation occurs where residual water is available, but as noted such areas have diminished. A net moderate positive impact is assessed.

In AED D there has also been a moderate positive impact. This results from the greatly increased cultivated area there. However, only B. Aman is possible and yields are poor relative to AED C. The long-term drainage and cultivation of the peat soils are likely to require inputs that the current level of farming can neither provide nor afford. Acidification, shrinkage and erosion are typical problems likely to occur. Nevertheless, there has been a substantial change.

Minor negative impacts on cultivation in the riverine areas are inferred from the loud complaints of farmers outside the embankments. No significant impact is likely in the DSA, where tidal influences dominate.

Table 11.4 Human Environmental Issues

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

Source: Consultants

Note: ? Uncertain impact.

b) Livestock

As Chapter 6 indicates, the Project Area seems to have only a negligible impact on livestock. Livestock numbers are unaffected but more is spent on purchased feedstuffs, although this not necessarily due to negative impacts of the Project. In fact, the extensive fallow areas in AED C are available for grazing probably rather earlier than before, while cleared reed-bed areas in AED D may provide dry-season grazing which was previously too wet and had too low a bearing capacity. Thus if anything, impact might be positive there. No significant impact occurs in the external areas.

c) Capture Fisheries

The deterioration in fish ecology caused by the Project has been assessed in Section 11.5.1 (b) above. The major negative impact of this on capture fisheries is discussed in detail in Chapter 7. It appears to be much greater overall than estimated by FAO (1989) and was ignored by pre-project economic appraisals.

The impacts assessed here reflect those in Section 11.5.1 (b), and for the same reasons.

d) Culture Fisheries

There has been a slight positive impact on culture fisheries through the improved security of fish and shrimp ponds, which are quite common in parts of AEDs A and B and on the narrow levee strips in AED C (Chapter 7). In addition, the sluices offer effective tidal water control for shrimp culture, although this is already a source of dispute between crop and shrimp farmers. The impact is weak at present but there is considerable potential for culture fisheries, including the advantage of large markets and the decline in capture fish-catches to be replaced.

The external areas are not affected significantly.

e) Afforestation

Practically nothing has happened in the way of afforestation or tree planting, despite serious fuelwood shortages. The opportunity for afforestation provided by the bund should be investigated and exploited to give maximum production and protection.

f) Agro-industrial Activities

There seems to have been some increase in rice-milling in the main villages (AEDs A and B) in response to the increased paddy production (Chapter 8). No impacts occur off-site.

g) Transport Communications

The Project has eased land communications by providing the embankment and the road along the dead Chitra River, crossing the area (Chapter 8). However, the substantial road improvements originally planned did not take place, as noted. The only vehicle ferry is a small one near Kalia on the Nabaganga River, although across the area in the north east there is a new bridge at Kalabaria on the Patna River. It is usually not possible to reach the south from the north along the embankment, and never along the Project's only road, which is devastated by cuts and subsidence. There is no car ferry to Khulna, so that the only vehicular traffic south of the dead Chitra River consists of mini-taxis, pedal tricycles, motorcycles and bicycles. The embankment does afford some protection for the very few internal roads.

It is evident that a road system suitable for cars, buses and lorries, plus a suitable ferry to Khulna, would have a huge impact on the Project Area. AEDs C and D in particular have suffered some negative transport impact caused by the exclusion of boat traffic, especially in the wet season. At present, only a net slight positive impact is registered for AEDs A, B and C. In AED D, which is not near the embankment, the positive effect is negligible.

River transport in the external areas, especially the WRA and DSA, is extremely important, so that the Project has had only a negligible effect on it.

h) Infrastructure

Major flooding events, including those related to coastal cyclones, have caused considerable infrastructural damage of houses and other property in the past. The Project has had a moderate positive impact (Chapter 10) in avoiding serious river flooding for the eight years of its existence. Public cuts to relieve drainage congestion occurred in 1987 and 1988 but no natural breaches. However, the bund requires repair and a risk element is developing. In AED D there is no infrastructure.

In the riverine areas damage is greater due to containment, even if temporary. There is a cumulative moderate negative impact. In the cyclone-prone DSA, any project impact is of no consequence.

i) Domestic Water Supply

There appear to be no impacts on domestic water supply derived from groundwater (Sections 11.4.1 (e) and (f)). A minor negative impact occurs in AED C where drainage congestion causes the khals to become stagnant and polluted. External areas are not affected.

j) Sanitation

As discussed in Section 11.4.1 (f) and (h), no significant problems appear to occur, although it would be interesting to monitor coeliform pollution in wetlands and groundwater, as elsewhere in Bangladesh. The polluted khals in AED C are not caused primarily by indiscriminate sewage.

k) Recreation

The only possible impact here is the weak minor positive effect on the Sundarbans National Park, an area of national and International importance.

l) Energy

Energy impacts are recognised only when energy is wasted (negative) or conserved or created (positive). No significant impact occurs.

11.6.2 Social Impacts

a) Human Carrying Capacity

The overall moderate positive impact on human carrying capacity reflects the improved crop production in particular, in AEDs A,B and C. Weighting the relative importance of crop cultivation and capture fisheries, however, it is apparent that in AED D, with its possible cultivation problems, the loss of fisheries reduces human carrying capacity improvement to at best a minor level. Even then, this is an uncertain assessment that requires more specific study.

b) Demography

Even with the Project, the nearby urban/industrial centres such as Khulna continue to attract young and middle-aged males from the population, reducing its growth and distorting the demographic structure. The Project, however, has probably helped to slow this trend, due to the increased human carrying capacity. A slight positive impact is assessed throughout.

Increased flooding in the riverine areas may have encouraged out-migration to urban areas but probably not significantly, as many families resident there own land on both sides of the embankment.

There is also no significant impact in the DSA.

c) Gender

A minor positive impact on the role of women by creating greater employment and participation opportunities has occurred in the areas most affected by the Project (AEDs C and D).

There are no significant off-site impacts. Chapter 9 considers gender issues further.

d) Age

No obvious impact arises, unless there are increased employment opportunities for the old and for children, in the latter case perhaps causing them to be removed from school too early. No data exist and such impacts are currently considered unlikely to be significant.

e) Health and Nutrition

No great changes in health status were claimed by the local people, although there were complaints about more mosquitoes on the stagnant khals in AED C. Seasonal peaks of food shortage among cultivating families have been reduced because of the increased food supplies and incomes (Chapter 9). This has been balanced to some extent by the diminished protein from fish, which is now very expensive, thus especially affecting the poor. The net impact, therefore, is only minor positive in the Project Area. The off-site impacts are unlikely to be significantly negative, as land is often owned on both sides of the bund.

f) Disruption, Safety and Survival

The main concern is disruption, as unlike many FCD projects, Kolabashukhali does not seem to have increased the potential for catastrophe significantly beyond what it already was. Disruption is now much reduced, especially in AED C and to a lesser extent in AEDs A and B. Potential disruption in AED D has a slight negative impact, since before there was little activity to disrupt in the division.

The riverine areas suffer increased disruption, causing a minor negative impact. The DSA is not affected.

g) Land Ownership

Changes in land ownership appear not to have been influenced significantly, apart from a general minor negative impact at the time when land was acquired for the embankment construction. This affected all the Project Area except AED D, and also affected the WRA and ERA.

h) Equity

The benefits of the Project have obviously favoured the large landowner or fish farmer considerably, thugh the landless have benefitted from some additional employment and higher wages (Chapter 10). Capture fishermen, on the other hand, have often lost everything; only in a few cases do they seem to have been allocated cultivation rights to the khas lands released in the beels. Inequity is therefore greatest in AED D, where it is moderate, with the balance of benefits elsewhere giving a neutral impact.

Increased flooding in the riverine areas accentuates the inequity between better-off families with land inside the embankment as well and those whose land is wholly affected. There is no DSA impact on equity.

i) Social Cohesion

Disputes over sluice operation between shrimp farmers and cultivators cause a minor negative impact in AED A (Chapter 9). The potentially much more serious threat in AEDs C and D, where capture fishermen have lost out so badly, seems to be ameliorated by some allocation of khas land to them and by their absorption into the increased cultivation activity resulting from the Project. Only a minor negative impact is assessed and this may be exaggerated.

There is obvious social division between winners and losers residing outside the embankment but these seem relatively minor. There is no DSA impact.

j) Social Attitudes

Despite the minor differences between social groups noted in (i) above, the Project seems to be generally appreciated.

In AEDs C and D, where it appears to have had the greatest impact, enthusiasm is slightly tempered by complaints over the drainage congestion.

Attitudes outside the embankment show a net minor negative impact. The DSA is unlikely to have been affected.

11.6.3 Economic Impacts

The three main potential economic impacts on the people are on incomes, employment and land values. These have all received positive impacts due to the Project (Chapter 10), generally in proportion to impacts on cultivation. However, in AED D the negative economic impact on fisheries reduces the net positive impact to slight. Overall net impact is assumed to be moderately positive, taking into account the extent of AED C and the strong minor impacts in AEDs A and B.

Off-site net impacts on incomes in the riverine areas also reflect the minor negative impacts on cultivation and fisheries. There are no DSA impacts. Land values, employment and credit availability are probably not significantly affected in the external areas.

11.6.4 Institutional Impacts

a) Institutional Activities/Effectiveness

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

Operation and maintenance at Kolabashukhali appear to be poor and have resulted in serious degradation in the project structures. The embankment needs repair along 30 per cent of its length, sluices are mostly inoperable or are leaking profusely, and drainage channels need excavation.

The most glaring inadequacy in the original planning and design is the one-vent sluice at Bhujania Regulator and the failure to excavate the Bhujania Khal drainage system fully. Bhujania drains much of the southern half of the area, including some of the wettest land, yet has only one-third the sluice capacity of Putimara Regulator, which drains only one small and relatively shallow beel. The Bhujania Khal is a stagnant, polluted channel which urgently needs opening up. The worst case of drainage congestion, not surprisingly, relates to Bhujania, although others occur.

Difficulties of access and cost are obvious, but BWDB has some urgent problems to tackle if the Project is not to start to deteriorate, despite its promising early years. The negative impact on institutional activity and effectiveness is mostly marked in AEDs C and D where drainage congestion causes problems.

The prominent role originally to have been played by DAE has not materialised, as the agricultural support component was subsequently dropped. Farmers seemed rarely to see Extension Officers and clearly felt that they themselves knew better how to grow B. Aman rice under beel conditions.

b) Public Participation

Some of the difficulties and disputes in operation arise due to unrepresentative public participation (Chapter 4). However, most local people interviewed during the environmental fieldwork voiced satisfaction with operation and seemed to feel that public participation was adequate. No significant impact is allocated here.

11.6.5 Cultural Impacts

It is difficult to see how the Project has influenced scenic qualities, unless Typha reed beds are deemed aesthetically superior to paddy fields. The only slight positive cumulative impact in this respect might be due to the assumed minor benefit to the Sundarbans National Park.

There seem to be no particular historical, archaeological or more recent sites of cultural note within the area or the adjacent riverine areas. DSA impacts are unlikely to be great enough to affect any of these issues further south.

Cultural continuity has suffered a substantial negative impact in AEDs C and D, where traditional and largely Hindu fishermen have lost their way of life, changing to become landless labourers or in a few fortunate cases marginal farmers of re-allocated khas land in the beels.

Overall, the quality of life in the Project Area has clearly improved, especially in AED C. A similar moderate positive impact in AED D is partially countered by the decline of the traditional fishermen's life style. In the riverine external areas there is a slight negative effect, while the influence on the Sundarbans can regarded as a minor positive impact on the quality of life.

11.7 ENVIRONMENTAL SCREENING

Environmental screening uses the scoping exercise carried out in Sections 11.4-11.6 to evaluate project activities in terms of their influence. The originally planned primary project activities were flood protection and drainage, accompanied by a roads programme, agricultural supports and some irrigation via the flushing sluices.

The roads and agricultural support components were cut to almost nothing and so have caused negligible environmental impacts. Any irrigation element was incidental to the drainage sluices and has had little significant impact, although flood protection seems to have encouraged STW development a little. Thus scoping shows that the key activities in terms of impacts have been flood control and drainage.

A considerable degree of flood protection has been achieved, although in very wet years there have been public cuts. The risk of flooding is greatly reduced and some 2000-5000 ha. have been reclaimed from perennial swamp land. Most of the Project's impacts derive primarily from flood protection, especially the positive ones.

The drainage component has been less successful and congestion is still a major problem in places. Thus this component has not created as much positive impact as it was hoped originally and has caused several negative impacts.

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11.8 CONCLUSIONS AND RECOMMENDATIONS

11.8.1 Conclusions

Conclusions can be summarised in terms of the main environmental impacts of the Kolabashukhali FCD Project in the Project area and on the external impact areas. Environmental impacts have been assessed by environmental scoping in Sections 11.4-11.6 and are presented in Tables 11.2-11.4. The agroecological divisions (AED) provide a spatial distribution perspective on impacts. They are defined in Figure 11.1 and Table 11.1. A consideration in Kolabashukhali is that background negative trends due to population pressure seem to be less pronounced than in many FAP 12 study areas.

a) The Project Area

There have been two major positive impacts taking the Project Area as a whole, although both result from the greater differential weighting given to AEDs C and D (which together account for over two-thirds of the Project Area). The major positive impacts are on soil moisture status and land availability. Both derive primarily from the removal of the once perennial flooding in AED D and the reduction in seasonal flood duration in AED C.

The following moderate positive impacts are identified:

i. the primary impact of improved flood levels, timing, rate of rise and duration, especially in AEDs D and C;

ii. improved land capability, notably in AED C;

iii. increased crop production, again particularly in AEDs C and D;

iv. protection of infrastructure from river flooding since 1983, although some risk is now developing;

v. a corresponding rise in human carrying capacity;

vi. a general appreciation of project benefits by people throughout the Project Area;

vii. a substantial improvement in the key socio-economic benefits of incomes, employment, land values and credit availability, with AED C gaining most;

viii. an overall improvement in the quality of life, especially in AED C.

While all of the Project area has benefitted, it is clear that positive environmental impacts have been greatest in AED C (Beel Margins), which accounts for 40.5 per cent of the Project Area. The physical impacts of flood control were most pronounced in AED D (Beel Centres: 27.5 per cent) but positive human net impacts there were reduced by negative impacts on capture fisheries and fishermen. The higher lands of the Low Ganges River Floodplain in the north (AED B: 23 per cent) and the High Ganges River Floodplain in the south (AED A: 9 per cent) benefitted less from flood control but suffered few of the negative human and biotic impacts which affected AED C and especially AED D.

Major negative impacts relate specifically to the loss of permanent wetlands in AED D and to a lesser extent to the reduced seasonal flooding and wetlands in AED C. Fish communities and habitats have suffered severely, even when measured against background negative trends caused by overfishing and disease. In human use terms, capture fisheries have suffered on the same scale.

A number of moderate negative environmental impacts arise, many of them related to the major impacts above:

i. a decline in soil fertility, with the usual deterioration that follows flood protection accentuated here by likely acidification, especially in the drained peaty soils;

ii. decline in bird communities and habitats, particularly with reference to waterbirds;

iii. micro-fauna communities and habitats were especially important in the perennial and seasonal beels, which have been so drastically changed;

iv. aquatic vegetation has suffered for the same reasons;

v. social equity has been badly affected by the demise of the fishing communities, on top of the generally biased distribution of project benefits towards the wealthy;

vi. the institutional response to the Project has been negligible by DAE and poor by BWDB; there is little agricultural support of relevance to the farmers, while inadequate project operation and maintenance threaten the overall success of the Project achieved in its initial years;

vii. cultural continuity has suffered, again due to the demise of the largely Hindu traditional fishing communities as social entities.

It is noticeable from Table 11.3 that the negative biotic impacts of the Project are more pronounced than in many other FAP 12 study areas. This results from the weaker background trends reflecting primarily population pressure, the main pre-project manifestation of which was the limited and generally sustainable exploitation of the peat beels (AED D).

The Project seems to have been generally successful and appreciated by the local people. Against this, however, must be set the ecological price of the peat beels and the socio-economic and cultural costs to the traditional fishermen. In addition, the success to date is threatened by the poor institutional performance, as are possible future improvements.

b) External Impact Areas

Tables 11.2-11.4 also show the Project's environmental impacts on the three external impact areas: the western riverine area (WRA); the eastern riverine area and Bhuter Beel adjacent area (ERA); and the downstream areas (DSA) of the Ganges Tidal Floodplain (FAO, 1988), which include Bangladesh's ecologically most important area, the Sundarbans National Park. Impacts in the WRA and ERA sometimes conflict with those downstream.

It is important to note that in respect of off-site impacts in all three external areas, it is the cumulative impact of all the numerous FCD projects along the Lower Ganges system that is assessed, rather than of Kolabashukhali in isolation. This approach avoids the unrealistic dismissal of what can be, cumulatively, important environmental influences.

In the WRA and ERA impacts are mostly negative and usually minor. All relate to the concentration of river (and tidal) flows by the embankment. Thus moderate negative impacts include higher river flows, with increased flooding against the embankments and in parts of Bhuter Beel. These in turn cause substantial infrastructural damage, especially to houses. Social inequity impacts are marked because the better-off residents outside the embankment invariably also own land within it, from which they obtain a net benefit; the poor outside the bunds are not compensated in this way.

There are no moderate positive environmental impacts in WRA and ERA and very few minor ones.

In the extensive DSA which receives the river flows from Kolabashukhali and related projects, most impacts are too widely dissipated and outweighed by the dominant tidal influences to be significant. The few impacts identified are all minor positive and derive from what is assumed to be the beneficial influence of the additional fresh water funnelled into the DSA by the embankments. This cumulative effect is not immediately obvious because the overall fresh-water inflow to the Tidal Floodplain has decreased markedly in recent decades, due chiefly to major Ganges diversions in India. A particularly victim of this decrease seems to have been the mangrove forests of the Sundarbans, which require fresh as well as sea water. Thus to a limited extent, Kolabashukhali and related projects may be helping to counter this negative ecological trend. However, modelling and quantification are needed to confirm that FCD projects do create a net improvement in the fresh-water balance in tidal rivers.

11.8.2 Recommendations

Recommendations include the following.

i. Urgent attention should be given to operation, maintenance and some re-design; in particular the Bhujania Regulator must be replaced by a very much larger structure and its drainage system properly excavated.

ii. Increased use of local labour for embankment repair and khal excavation would improve maintenance and promote employment and social equity.

iii. The exploitation of the peat wetlands should be carefully monitored; this will eventually happen in other parts of Bangladesh and it is likely that there are lessons to be learned, problems to be avoided and sound advice to be formulated.

iv. The possibility of impounding the lowest areas to provide dry-season irrigation and fish refuges, perhaps after excavation of peat for fuel, should be examined.

v. Whenever possible, khas land in the released wetlands should be allocated to displaced fishermen, making (iii) even more important.

vi. The development of fishponds in AEDs A, B and C should be facilitated, especially for groups of displaced fishermen.

vii. The potential for groundwater development deserves more detailed attention. Given the large amount of land now available for dry-season irrigation, attention to the quality and cost aspects of tubewell development might be amply rewarded.

viii. For the same reason, detailed monitoring of the current pattern of river salinities could allow more irrigation than thought possible in the past. Farmers' long-established knowledge of river salinity may be out-dated by the containment effects of recent years. Certainly the fears expressed in the Feasibility Study, based on a salinity limit of 500 μmhos/cm for perfect irrigation water were alarmist. This is the standard limit for perfect irrigation water (see Table 7.2 in the FAP 12 (1991b) Methodology Report); usable water can be upto 2250 μmhos/cm, especially for rice.

ix. A more socio-economically equitable and efficient means of operating sluices is required;

x. The potential for embankment protection and production using trees, shrubs and/or grasses should be explored;

xi. Consideration should be given to installing the previously envisaged vehicle road system, accompanied by a vehicle ferry to Khulna.

xii. An environmental project audit is recommended, to provide more detailed environmental data and analysis, especially of the ecological and long-term socio-physical implications of developing peat beels in Bangladesh. The problem, as always, is the absence of any ecological baseline data.

12 ECONOMIC ASPECTS

12.1 PROJECT COSTS

The Kolabashukhali Project was built between 1979 and 1984, though some costs attributed to construction under Food For Work and Flood Damage Rehabilitation programmes continued up to 1986 (FAO 1989, Figure 1 and Table 5). For the economic reappraisal of the Project, expenditures up to 1984/85 have been included in capital costs, those thereafter being considered as part of O&M expenditure. The implementation period was thus six years, which although not rapid was in line with the original project planning. In this respect KBK contrasts strongly with most other large FCD projects, including the adjacent Chenchuri Beel Project financed under the same IDA credit.

The financial and economic costs of the Project are presented in Table 12.1. Financial costs were Tk. 224.2 million in constant 1991 Taka. The capital cost per hectare of net benefited area is Tk. 12041, which is well above the median of the seventeen projects investigated by FAP 12 (Tk. 7962), but is close to the average for large FCD projects (over 10000 ha.) without a major irrigation component. The O&M cost of Tk.11.6 million per annum began to be incurred from 1985/6, after the completion of the Project. The O&M cost per hectare of benefited area is Tk. 624, which is once again on the high side. Out of the seventeen projects, only two had a higher O&M figure per hectare, one of these being the high-cost pumped-drainage scheme at Meghna-Dhonagoda (also the subject of a FAP 12 PIE survey). As noted in Chapter 4, substantial parts of the Kolabashukhali O&M budget represent costs incurred for rehabilitation and/or additional structures, and the budget also carries a considerable unproductive staff overhead. However, these costs have been retained in the cash flows, as representative of the typical operating environment of BWDB projects.

12.2 AGRICULTURAL IMPACT

The main impact of the KBK project is on agriculture, and more specifically on Aus and Aman paddy. However, the impact is not limited to a pure flood protection role, although this is the main impact. Additional impacts have stemmed from the fact that the project has enabled new lands to be brought under cultivation (the reclamation effect).

The methodology for judging impact is by a comparison of results from a household survey of the Project area with the comparable results from a control area selected as representative of the without project situation. This cross-sectional comparison, however, will underestimate the impact because of it does not reveal the reclamation effect, because the reclaimed land had no agricultural operator pre-Project and therefore does not appear in the sample. Evidence on the extent of the reclamation effect is therefore drawn from the FAP 12 RRA survey and from the Project Feasibility Report; these sources indicate reclamation of between 2000 and 5000 ha., with the true impact probably towards the upper end of the range.

Table 12.2 present estimated financial and economic data on costs and returns of paddy cultivation (inclusive of byproduct values), for the Project and control areas, and derives the net incremental benefit per hectare. Data on the net benefited area (cultivable area) and the cropping intensity allow extrapolation to the whole project.

Table 12.1 Financial and Economic Costs of Kolabashukhali Project
(Tk.'000 in 1991 prices)

Year	Financial		Economic	
	Capital	O&M annum	Capital	O&M/annum
1978/9	1300		780	
1979/80	6900		3200	
1980/81	15890		8790	
1981/82	37170		22700	
1982/83	93280		62600	
1983/84	46150		31800	
1984/85	25000		17500	
Total	224240	11600	147400	8000

Sources and notes: Based on FAO (1989). Economic conversion factors from FPCO (1991). Inflation indices used to arrive at 1991 prices were the Agricultural Wage Rate Index, the Construction Cost Index and the IBRD MUV Index (BBS 1990 and IBRD 1991).

In economic terms, the net returns per hectare for the Project and control areas are Tk. 6698 and Tk 3152, yielding a value of Tk. 3546, which is the project impact per hectare. Total economic value of project yield impact is estimated at Tk. 81.2 million. The figure however, does not reflect the reclamation effect.

Table 12.2 Costs and Return to Paddy Cultivation and Net Benefits Per Hectare, Financial and Economic Values (1991 Prices).

	Project		Control	
	Fin	Eco	Fin	Eco
Gross Output	9421	9038	6313	6123
Byproducts	2953	2412	1258	1031
Cost	5794	4752	5015	4002
Net Return	6580	6698	2556	3152

Change Attributable to Project: Financial Tk. 4024/ha.
Economic Tk. 3546/ha.

Project Agricultural Benefits= *Net Cultivated Area* × *Cropping Intensity* × 3546
= *Tk.* 81203 (*thousand*)

Source: Based on PIE. Conversion factor for shadow pricing from FPCO (1991).

A straight forward with/without comparison will therefore under-estimate benefits, so that the figure on project benefits in Table 12.2 needs to be adjusted for the reclamation effect.

Although there are strong indications of considerable project success in reducing water levels and duration of inundation on the lowest land (see Chapter 4) there is no firm estimate of the additional area made available. The original project objective was to reclaim the area of approximately 3800 ha. at an elevation of 0.15-0.60 m. PWD (see Chapter 2), while the RRA tentatively estimated that as much as 5000 ha. might have been reclaimed; the latter figure would have to include some unused land above 0.60 m.. Two different estimates of the area reclaimed by the project have therefore been used: the high estimate from the RRA (5000 ha. - reclamation effect B) and a low estimate an equal distance below the project target (2600 ha - reclamation effect A). Assuming the additional land is all cropped to B Aman (in line with the Feasibility Study) these give alternative project benefits of Tk. 100.6 million and Tk. 91.3 million respectively.

12.3 NEGATIVE IMPACTS

Negative effects, particularly on fisheries, have been reported, but these are unlikely to upset conclusions based on agricultural impact. The RRA estimated the value of fisheries losses to be as high as 23 per cent of the value of the incremental crop output, somewhat offset by increased culture fisheries, but this seems likely to be a high estimate. The PIE (Chapter 7) has estimated lost fish catch at between 283 and 483 mt/year, valued at Tk. 7.5 to Tk. 12.8 million (1991 economic prices), the upper estimate being about 14 per cent of agricultural benefits (including reclamation effect A).

No other major negative impact was identifiable, with the possible exception of livestock, which tend to suffer due to a reduction in the grazing area.

12.4 BENEFIT - COST ANALYSES

12.4.1 Base Scenario

The benefit-cost analysis for KBK uses three alternative benefits streams. The base scenario (B1) reflects the simple difference between the with- and without-project situations to yield the incremental value of paddy output (Aus and Aman only). In B2 and B3 the effect of the land-reclamation element of the project on paddy output is also taken into account, using the two different estimates of the reclamation effect. For all scenarios the upper estimate of fishery losses is used.

Even in the most modest scenario (B1), the estimated IRR is 22 per cent, while under the most optimistic scenario (B3), the EIRR rises to 27 per cent. The base case with low reclamation effect, yielding an EIRR of 24 per cent, is probably the best estimate of Project economic performance (Table 12.3 and 12.4).

A simple sensitivity analysis was performed with the assumption of 5 per cent lower (average) yields for monsoon paddy in the with situation and a similar increase in the without situation. Starting from the base scenario (B1), this gives a reduction in the EIRR from 24 per cent to 18 per cent - still a healthy performance.

12.4.2 Sensitivity to Statistical Uncertainty

The yield estimates from which the benefit streams were calculated are based on sample data and hence are subject to a margin of error. The base scenario (B1) described above, and its variants (B2 and B3) are based on the difference between the estimated mean yields in the project and control areas. These estimates are however only the most likely single points in a probabilistic range of variation. To test the sensitivity of the economic analysis to the built-in variability of the sample data, maximum and minimum yield differences between project and control were estimated, based on the upper and lower 75 per cent confidence limits for the two areas. This gives a minimum estimate of yield difference of 0.15 mt./ha and a maximum estimate of 0.87 mt./ha (compared with the difference of 0.51 mt./ha. used for the base scenario).

The minimum estimate of yield impact (0.15 mt./ha), with reclamation effect A, yields an EIRR of 5 per cent, while the same yield impact with reclamation effect B yields an EIRR of 14 per cent. On the other hand, the maximum estimate of yield impact, with reclamation effect A, gives an EIRR of 31 per cent. It should be noted that in all these estimates, the reclamation effect was not allowed to vary, and was based on the average yield figure for the control area.

The range of benefits and the corresponding EIRRs are indicated in Table 12.3.

Table 12.3 Sensitivity Analysis of EIRR Under Different Benefit Assumptions

Benefit Assumption	Benefit (Tk. m)	EIRR (%)
Basic Yield Benefit (B1)	81.2	21.7
Base + Rec A (B2)	91.3	24.3
Base + Rec B (B3)	100.6	26.5
Minimum Yield Impact		
With Rec A	30.0	2.1
With Rec B	39.3	7.5
Maximum Yield Benefit		
With Rec A	128.3	32.4
With Rec B	137.6	34.1

Source: Based on PIE.

Notes: Reclamation effects are constant at Tk 10.1 m. for case A and Tk 19.4 m. for case B.

Table 12.4 Economic Cash Flow - Basic Scenario with Low Reclamation Effect
(Tk. million in 1991 economic prices)

Year	Capital Costs	O&M Costs	Total Costs	Agri- cultural Benefits 1/	Fish- eries Losses 2/	Net Agric. & Fishery Benefits	Net Economic Benefits
1979 / 80	0.78		0.78	0		0	-0.78
1980 / 81	3.18		3.18	0		0	-3.18
1981 / 82	8.79		8.79	0		0	-8.79
1982 / 83	22.68		22.68	0		0	-22.68
1983 / 84	62.6		62.6	0		0	-62.6
1984 / 85	31.8	8	39.8	0		0	-39.8
1985 / 86	17.5	8	25.5	22.825	-12.85	9.975	-15.525
1986 / 87		8	8	45.65	-12.85	32.8	24.8
1987 / 88		8	8	68.475	-12.85	55.625	47.625
1988 / 89		8	8	91.3	-12.85	78.45	70.45
1989 / 90		8	8	91.3	-12.85	78.45	70.45
1990 / 91		8	8	91.3	-12.85	78.45	70.45
1991 / 92		8	8	91.3	-12.85	78.45	70.45
1992 / 93		8	8	91.3	-12.85	78.45	70.45
1993 / 94		8	8	91.3	-12.85	78.45	70.45
1994 / 95		8	8	91.3	-12.85	78.45	70.45
1995 / 96		8	8	91.3	-12.85	78.45	70.45
1996 / 97		8	8	91.3	-12.85	78.45	70.45
1997 / 98		8	8	91.3	-12.85	78.45	70.45
1998 / 99		8	8	91.3	-12.85	78.45	70.45
1999 / 2000		8	8	91.3	-12.85	78.45	70.45
2000 / 1		8	8	91.3	-12.85	78.45	70.45
2001 / 2		8	8	91.3	-12.85	78.45	70.45
2002 / 3		8	8	91.3	-12.85	78.45	70.45
2003 / 4		8	8	91.3	-12.85	78.45	70.45
2004 / 5		8	8	91.3	-12.85	78.45	70.45
2005 / 6		8	8	91.3	-12.85	78.45	70.45
2006 / 7		8	8	91.3	-12.85	78.45	70.45
2007 / 8		8	8	91.3	-12.85	78.45	70.45
2008 / 9		8	8	91.3	-12.85	78.45	70.45
2009 / 10		8	8	91.3	-12.85	78.45	70.45
2010 / 11		8	8	91.3	-12.85	78.45	70.45
2011 / 12		8	8	91.3	-12.85	78.45	70.45
2012 / 13		8	8	91.3	-12.85	78.45	70.45
2013 / 14		8	8	91.3	-12.85	78.45	70.45
2014 / 15		8	8	91.3	-12.85	78.45	70.45

Source: Consultants

Economic Internal Rate of Return %	24.26
Benefit:Cost Ratio @ 12% discount	2.18
Net Present Value (Tk. million) @ 12% discount	159.44

Notes: 1/ With low estimate of reclamation effect (2600 ha.)
2/ At higher estimate of fishery losses.

12.5 CONCLUSIONS AND RECOMMENDATIONS

12.5.1 Conclusions

The economic reappraisal yields a range of EIRRs which suggest, under most outcomes within the likely range of variation, the Kolabashukhali Project is definitely economically viable. FAP 12's analyses of the economic performance of FCD projects suggests that it is the smaller projects, generally under 10000 ha net benefited area (i.e. about half the size of KBK or less) which have the best chance of achieving satisfactory economic performance. The implied size limit is potentially constraining for regional and national FCD strategy, and it is worth considering what factors enable a large project like KBK to perform well.

As noted above, KBK is exceptional among large projects in that it was completed more or less within the originally planned time-frame, and within the original (Taka) cost estimate. Both factors have strong influence on the ability to produce a good rate of return. The original cost limits were maintained, in the face of major escalation in some elements (notably land acquisition, see FAO 1989), by curtailing expenditure on other aspects (especially the strengthening of the agricultural extension service, and the roads programme). These cost reductions have since proved to be sources of weakness in project performance, and it might have been preferable to retain them, even if this meant a cost overrun.

The timely completion of the Project appears to owe much to two factors:

i. the basic concept of the Project was straightforward, and although there have been problems with some structures, the basic scope of works was within the capabilities of BWDB and its consultants and contractors so far as design, investigation, construction and supervision were concerned. In this respect KBK differs from some more complex large projects, such as Meghna-Dhonagoda Irrigation Project in the FAP South-East Region;

ii. although there were large cost overruns on land acquisition, the actual process of acquisition did not delay construction (unlike the neighbouring Chenchuri Beel Project), and this in turn seems to reflect the generally strong sentiment in favour of the Project and the steps taken to form local consultative committees during implementation (see Section 10.8). The inference seems clear that early action to establish consultation with the affected population of FCD projects is repaid many times over.

12.5.2 Recommendations

Looking to the future, Kolabashukhali Project has already incurred its major costs for construction and in loss of capture fisheries. It has achieved considerable agricultural impact, but by no means all that was originally anticipated, largely due to the continuing problems of drainage congestion in catchments with inadequate or deteriorated drainage facilities. Remedying these problems would probably produce considerable additional agricultural gains, particularly by facilitating the transition (at present very partial) from B Aus/Aman to T Aman, at relatively low cost. It is therefore recommended that the necessary enhancement and rehabilitation of the drainage facilities should be examined as a matter of priority.

The Project's successes in agriculture, and increasingly in culture fisheries, have been achieved in the face of almost complete lack of support by DAE and DOF. The original programme for strengthening DAE should be implemented, and similar action should be taken for the local offices of DOF. The latter action should be integrated with the activities of the ODA Third Fisheries Project, which is undertaking beel restocking in KBK.

The road communications within KBK, and especially the connections with the regional centre, Khulna, are extremely poor. The present cropping patterns, which are dominated by B Aman and Aus/Aman, have low input requirements, and are therefore not seriously constrained by the poor communications. If a widespread move into T Aman were to take place, input requirements would increase sharply, and transportation could become limiting. It is therefore recommended that, as part of a long-term package of area development measures, the originally planned road programme should be completed, and the incomplete and damaged sections of the existing roads should be rehabilitated.

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B. Maps

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