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

BANGLADESH FLOOD ACTION PLAN

FAP 12
FCD/I AGRICULTURAL STUDY

FINAL REPORT

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Appendices K - P

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

The full series comprises the following reports:

FAP 12

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

Project Impact Evaluation studies of:

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

Rapid Rural Appraisal Studies of:

Protappur Irrigation Project
Nagor River Project
Sonamukhi Bonmander Beel Drainage Project
Improvement of Sakunia Beel
Silimpur-Karatia Bridge cum Regulators
Khatakhali Khal
Halir Haor
Kahua Muhuri Embankment
Konapara Embankment [1]
Polder 17/2
BRE Kamarjani Reach [1]
BRE Kazipur Reach [1]

Draft Final Report (4 Volumes)
Final Report (4 Volumes)

FAP 13

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

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

APPENDIX K

IMPACT ON NON-FARM ECONOMIC ACTIVITIES

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APPENDIX K

IMPACT ON NON-FARM ECONOMIC ACTIVITIES

K1 BACKGROUND

Non-farm activities are essentially the small and rural industrial activities. In dealing with such activities, we have not considered activities under fishing, livestock and forestry - the subsectors which fall in agriculture in the broader sense of the term. We have, however, included trading activities (e.g. dealing in rice and agricultural inputs), shop keeping and transport business (e.g. rickshaw, rickshaw van, boat).

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 so many variables influencing the changes, there are serious problems in segregating the impacts attributable fully or directly to the projects.

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. The PIE case studies were conducted in both impacted and control areas. The sample number ranges from 31 to 33 in each of the PIE areas. In all, 159 enterprises were interviewed, of which 81 were in the impacted areas and 78 in control areas. Table K1 shows the distribution of sample units by projects. Because of the purposive nature of sampling, the data have not been subjected to statistical analysis and testing.

During the case studies the key aspects investigated were level (number of units) of activities, seasonality, employment (annual person days worked), production, income and demand. Given that there is a wide range (more than 60) of non-farm activities, selection of the limited number of case studies attainable posed problems. However, respondents were 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. Annual return figures, however, have been standardised in the form of return to family labour and management. This approach avoids the problems of imputing a wage rate for family labour, much of which is part-time and remunerated at levels well below the market wage.

Table K1 Sample Enterprises by Project

Project	Number of sample units		
	Impacted	Control	Total
Chalan Beel D	15	18	33
Kurigram South	15	16	31
Meghna Dhonagoda	15	18	33
Zilkar Haor	16	15	31
Kolabashukhali	20	11	31
Total	81	78	159

Source: PIE case studies.

K2 OVERALL PROJECT IMPACTS

Based on the findings of the RRAs, and on the case studies of rural enterprises made during the PIEs, an attempt has been made to scale the degree of impact the projects have had on various non-farm activities. In scaling the impacts, changes in key variables such as level (number 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.

The scale of "overall impact" is as follows:

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

Table K2 summarises the overall impacts the different projects have made on ten major non-farm activities. As is evident from the table, a total of 4 projects are assessed as having made little or no impact; these are:

Kurigram South;
Nagor River;
Silimpur-Karatia; and
Halir Haor.

Table K2: Impact of FCD/I Projects on Selected Non-farm Activities

Project	Rice Milling	Wood cane & bamboo products	Furniture & carpentry	Black-smithing	Light engineering	Ag. Input Trading	Rice Trading	Rickshaw/van Transport	Water Transport	Earth-work	Overall impact
Chalan Beel	+1	+1	+1	+1	+0	+2	+1	+1	-1	+1	Minor
Kurigram South	+1	0	0	+1	0	0	0	+1	0	+1	Negligible
Meghna-Dhonagoda	+3	+1	0	+2	+2	+2	+2	+2	-1	+3	Major
Zilkar Haor	+1	+1	0	+2	+0	+1	+2	+2	-2	+1	Minor
Kolabashukhali	+1	0	+1	0	+1	+1	+1	+1	-2	+1	Minor
Protappur	+2	+1	+1	+2	+2	+1	+2	+1	0	+1	Moderate
Nagor River	0	-1	0	-1	0	+1	0	+1	0	+1	Negligible
Sonamukhi-Banmander	+2	+1	0	+1	+1	+1	+2	+1	0	+1	Moderate
Sakunia Beel	+1	0	0	+2	0	+1	+1	+1	-1	+1	Minor
Silimpur-Karatia	-1	0	+1	0	0	0	+1	+1	-2	+1	Negligible
Katakhali Khal	0	0	+1	0	+1	+1	+1	+2	0	+1	Minor
Halir Haor	+1	0	0	0	0	0	0	+1	-1	+1	Negligible
Kahua Muhuri	+2	+1	0	+1	+1	+2	+2	+2	0	+2	Moderate
Konapara	+1	+1	0	0	+1	+1	+1	+2	0	+1	Minor
Polder 17/2	+1	0	0	+1	+1	+2	+2	+2	-1	+1	Minor
BRE Kamarjani	+2	+1	0	+1	+1	+2	+2	+2	0	+3	Moderate
BRE Kazipur	+1	0	0	+1	+1	+1	+1	+1	0	+2	Minor

Individual Impacts

0 = Nil or Negligible impact
1 = Minor impact
2 = Moderate Impact
3 = Major Impact

Overall Impact

0 - <5 Nil or Negligible
5 - <10 Minor Impact
10 - <15 Moderate Impact
>15 Major Impact

Source: PIEs and RRAs

A total of 8 projects are assessed as having made minor impacts. These are:

Chalan Beel D;
Kolabashukhali;
Zilkar Haor;
Sakunia Beel;
Katakhali Khal;
Konapara;
Polder 17/2; and
Brahmaputra Right Embankment (Kazipur reach).

The 4 projects assessed as having created moderate impacts are:

Protappur;
Sonamukhi-Banmander;
Kahua Muhuri; and
BRE (Kamarjani reach).

One of the 17 study projects - Meghna-Dhonagoda - is assessed as having had a major impact on non-farm activities.

K3 LEVEL OF ACTIVITIES

The project areas generally support a variety of non-farm activities based mainly on local resources and skills. These include, among others, rice milling, wood, cane and bamboo products, saw mills, carpentry, boat making, blacksmithing, light engineering workshops, trading, transportation and earthworks.

K3.1 Paddy and Oil Milling

Intensification of paddy production has usually given rise to mechanised rice milling in the project areas except in a few cases (e.g. Kurigram, Nagor River, Silimpur-Karatia and Katakhali Khal) where the projects have had limited success in paddy production. Small husking mills are, however, usually powered by STW engines, and their spread is correlated with that of minor irrigation. For this reason, there is little mechanical husking in Kolabashukhali, where there is little scope for irrigation. All the PIE areas except Kurigram South have experienced high growth in rice mills. The relative increases in project areas compared to control areas in all these PIE areas are also remarkable. Growth in Kurigram South is less in the impacted area than in the control area, perhaps because of higher use of minor irrigation equipment in the control area. Silimpur-Karatia is a case where the number of rice mills has declined. In quite a number of projects, automatic rice boilers have flourished in and around project embankments. Besides, large numbers of small rice hullers, operated with STW engines on a seasonal basis, have emerged. With the growth of rice mills, however, the traditional method of rice husking by dheki has declined. Almost all the PIE and RRA areas have shown a decline in the number of oil presses, both power and manually operated, presumably because of general decline in oilseed production in the project areas.

K3.2 Output and Input Trading and Equipment Supply

Like rice milling, trading in general and rice trading in particular has considerably increased. With the increased use of agricultural inputs such as fertilizer, seeds and pesticides, trading in such items has registered a marked increase in almost all the project areas. The increased intensity of cultivation coupled with increased use of mechanised irrigation and cultivation equipment has generally increased the demand for manufacture and repair of implements. Blacksmiths producing agricultural tools (e.g. spades, weeders, harvesters) have generally increased in number. Light engineering workshops engaged mainly in repair of irrigation equipment and manufacture of small spare parts for rice mills have shown modest growth in a majority of projects. The survey results may understate project impact on this type of enterprise, which is likely to be concentrated in towns (e.g. Khulna, Sylhet, Kurigram and Matlab) adjacent to FCDI projects, rather than in the projects themselves. It also appears that the spread of this type of enterprise, like that of mechanical rice husking, is correlated with the spread of minor irrigation equipment.

K3.3 Woodworking Crafts

Saw mills have registered a very modest growth in RRA areas while in the PIE areas there has been no growth at all except slightly in Kurigram. A wide range of products from wood, cane and bamboo are produced in the form of containers (particularly for storage purposes), winnowers, hoes, yokes and ploughs, but there has not been any significant growth in this type of activity. The activity of boat making, however, has significantly increased in some project areas, presumably because of recent popular use of low cost engines with country boats. Chalan Beel, BRE-Kazipur and Kamarjani are the areas in particular where this has happened. It is difficult, however, to associate growth in boat making with FCD/I projects, which normally have an adverse impact on water transport, though there is an indirect linkage when projects encourage the growth of minor irrigation using STW engines which have alternative applications as boat power plants.

K3.4 Transportation

The improvement in communication created through embankments, and in quite a few cases by additional link roads and other infrastructure constructed by FCD/I projects, has facilitated a widespread increase in the use of simple low-cost transport like rickshaws and rickshaw vans. Nevertheless, quite a few projects have had clear negative impacts on the number of boatmen.

Table K3 **Growth of Selected Non-farm Activities (5 PIE Areas)**

Activities	% Change in number of units											
	Chalan Beel D		Kurigram South		Meghna-Dhonagoda		Zilkar Haor		Kola-bashukhali		All Projects	
	I	C	I	C	I	C	I	C	I	C	I	C
Rice mill	+343	+222	+600	+1200	+383	+42	+33	+25	+275	+175	+270	+147
Oil press	nil	+300	-25	+80	nil	+200	nil	+100	-100	+67	-28	+109
Saw mill	nil	+300	+50	nil	nil	+100	NA	NA	nil	nil	+20	+140
Eng. Workshop	nil	+200	+300	+350	+200	nil	NA	NA	nil	nil	+140	+186
Ag. Input marketing	+600	+100	+130	+233	+263	+167	+150	nil	+400	+67	+246	+124

Notes: I= Impacted C = Control

Source: Community Survey

Table K4 Growth of Selected Non-farm Activities : Chalan Beel

Activities	No. of units					
	Impacted Area (23 villages)			Control (12 villages)		
	Before	After	Change (%)	Before	After	Change (%)
Rice mill	7	31	343	9	29	+222
Oil press	1	1	nil	1	4	+300
Saw mill	1	1	nil	2	8	+300
Light Eng. Workshop	1	1	nil	3	9	+200
Ag. Input marketing	3	21	+600	5	10	+100

Source: Community Survey

Table K5 Growth of Selected Non-farm Activities: Meghna Dhonagoda

Activities	No. of units					
	Impacted Area (20 Mouzas)			Control Area (12 Mouzas)		
	Before	After	Change (%)	Before	After	Change (%)
Rice mill	18	87	+383	24	34	+42
Oil press	1	1	NIL	1	3	+200
Saw mill	1	1	NIL	1	2	+100
Light Eng. Workshop	2	3	+200	1	1	NIL
Ag. Input marketing	8	29	+263	6	16	+167

Source: Community Survey

Table K6 Growth of Selected Non-farm Activities: Kurigram South

Activities						
	Impacted Area (24 Mouzas)			Control Area (12 Mouzas)		
	Before	After	Change (%)	Before	After	Change (%)
Rice mill	3	21	+600	2	26	+1200
Oil press	12	9	-25	5	9	+80
Saw mill	2	3	+50	1	1	Nil
Light Eng. Workshop	1	4	+300	2	9	+350
Ag. Input marketing	10	23	+130	3	10	+233

Source: Community Survey

Table K7 Growth of Selected Non-farm Activities: Zilkar Haor

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

Source: Community Survey

Table K8 Growth of Selected Non-farm Activities: Kolabashukhali

Activities	No. of units					
	Impacted (19 Villages)			Control (9 Villages)		
	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 Eng. Workshop	1	1	Nil	1	1	Nil
Ag. Input marketing	1	5	+400	6	10	+67

Source: Community Survey

K4 EMPLOYMENT

The high growth of rice mills has given rise to employment opportunities in almost all the project areas. Automatic mills and boilers, particularly, have helped generate considerable employment. Small rice hullers are, however, operated mostly in the off seasons, and on a part time basis; and the spread of these rice hullers is dependent on use of irrigation equipment. It has generally been observed that growth of rice mills and employment opportunities has been less in those projects having fewer irrigation facilities. Thus, the employment in rice mills, especially in small hullers, is not fully attributable to the projects. With the growth of rice mills on the other hand, the traditional method of husking has declined, resulting in considerable displacement of the female labour force previously employed in this activity. This displacement, however, has been partly compensated through additional female employment in cleaning and processing jobs in large rice mills and boilers.

Like rice milling, the activity of rice trading has been able to support employment of, in particular, distressed women in large numbers through rice processing. The growth of rice mills and rice trading, which obviously have linkages with transportation, input supply and engineering workshops, have also indirectly increased non-farm employment opportunities.

The working periods of the agricultural tool making enterprises such as blacksmiths and wood and bamboo products (e.g. for ploughs and yokes) have generally increased.

The FCD/I projects in general have limited navigation and have in consequence shortened the working periods of boatmen and fishermen. Paradoxically, however, in a few project areas (e.g. Chalan Beel), the working periods for boat making have considerably increased. The improved communication net work has facilitated a positive change in employment conditions, access to resources, marketing and distribution systems. More crops, fruits, vegetables and merchandise are now marketed, creating, in particular, part time or full time employment in small scale trading and low-cost road transport. The road transport sector is the sector where significant direct employment generation has taken place for all the projects under study. It is believed that the negative impacts on boatmen have largely been offset by the increased employment opportunities in the road transport sector.

Construction of embankments and other infrastructure has always been a short term non-farm employment opportunity. During the operation and maintenance work, additional employments are generated to the disadvantaged including the distressed women. In most of the projects, this can be seen as a major impact to the non-farm activities. In many of the projects, as it was observed, various NGOs have come forward to help generate employment opportunities to the rural poor through earthwork and other related development work.

Tables K9 and K10 give some information on employment in selected enterprises in PIE areas, the former giving changes in annual working days in selected enterprises and the latter, person days per unit employed at present. It may be recalled that the enterprises vary widely in capital, scale and capacity utilisation, and given that the sample by type is small (ranging from 1 to 3, at most), it has not been possible, in many cases, to perform like with like comparisons. For this reason, the information provided in these tables is indicative and gives only a general picture of the state of the selected non-farm activities. As is evident from Table K9, for almost all the activities in most of the PIE impacted areas there has been some increase in their annual working days, compared to in the pre-project situation. The largest relative increases appear to have taken place in rice mills and rice trading. In the case of other activities, however, the increase relative to the control areas has not been very considerable. In the absence of data on the situation before the project, Table K10, as already mentioned gives only the present state of person days employed in various activities. As can be seen from the table, compared to the control areas, the average number of person days employed in the impacted areas in rice mills is higher for all the areas except Chalan Beel and Kurigram, and the situation is similar for rice trading. In the case of blacksmiths, however, all the PIE areas show relatively higher person days employed in the impacted areas.

Table K9 **Changes in per Enterprise Annual Working Days : PIE Projects**
(% change over pre-Project level)

% Change in annual working days per enterprise												
PIE Areas	Rice Milling		Black-smithing		Grocery/ Stationery		Rice trading		Road transport		Water transport	
	I	C	I	C	I	C	I	C	I	C	I	C
Chalan Beel	NA	0	+10	0	0	+4	NA	0	NA	0	0	0
Kurigram	+56	0	+25	+21	+12	0	-1	+3	+13	+5	NA	+25
Meghna Dhonagoda	+20	-6	+20	+18	-2	0	+15	+12	+10	+10	-18	-12
Zilkar Haor	+20	-12	+47	-11	+50	0	+33	0	NA	NA	-31	0
Kolabashukhali	0	NA	0	NA	NA	0	0	NA	0	NA	NA	0

I = Impacted area C = Control area NA = Not Available
Source : PIE Case Studies.

Table K10 Person Days Employed Per Unit of Selected Enterprise at Present : PIE Projects

PIE Projects : Person days (annual) employed per enterprise												
Project	Rice Milling		Black-smithing		Grocery/ Stationery		Rice trading		Road transport		Water transport	
	I	C	I	C	I	C	I	C	I	C	I	C
Chalan Beel	480	1080	660	600	720	480	330	1650	315	312	490	480
Kurigram	624	1440	270	630	360	1376	250	474	260	588	480	200
Meghna Dhonagoda	750	570	420	303	678	260	286	398	314	296	630	435
Zilkar Haor	600	368	312	234	180	360	480	180	312	NA	340	420
Kolabashukhali	4680	180	600	NA	325	100	510	60	NA	115	600	696

Notes: I = Impacted area C = Control area NA = Not Available

Source : PIE Case Studies

K5 PRODUCTION AND INCOME

Based on the findings of the RRAs and the PIE case studies, it can be said that the projects in most cases have experienced increase in production by rural enterprises. Intensification of paddy production, as expected, has invariably given rise not only to increased numbers of rice mills, but also to higher capacity utilisation in rice mills in the project areas. Silimpur Karatia is the case where both the number of rice mills and per enterprise production have declined. Kurigram, Nagor River and Katakhali Khal are projects where the level of production by rice mills has remained more or less unchanged.

Almost all the projects have shown a decline in oilseed crushing, presumably because of decline in oilseed production in the project areas. Production of containers, winnowers, hoes, yokes and ploughs has shown a moderate growth. Production in boat building has increased in few areas (e.g. Chalan Beel), but this is not attributable to project impact; in most projects it has decreased.

In the PIE case studies, the respondent entrepreneurs were asked the extent of changes (if any), compared to the pre-project situation, that had taken place in production and income from their respective enterprises. The weighted averages of the resultant changes (positive or negative) in production and income have been presented in Table K11. As can be seen from the table, considering all types of selected enterprises together, the overall change of production is positive in all the impacted areas, while in all but two control areas (Kurigram and Kolabashukhali) it is negative. The relative change in production for all the impacted areas except in Kurigram is also positive. As regards income per enterprise, again the changes in the impacted areas relative to those in the control areas are all positive except in Kurigram and Kolabashukhali.

Table K12 gives information on present annual income per family worker from selected enterprises. It can be seen that, compared to the control areas, income per family worker in

general is higher in the impacted areas, except perhaps in those cases where there were large differences in capital employed.

Table K11 Changes in Overall Production in and Income from Non-farm Activities (compared to in pre-project situation).

Projects	% Change per enterprise in			
	Production		Income	
	Impacted	Control	Impacted	Control
Chalan Beel	+2.1	-1.7	+1.2	-0.7
Kurigram	+5.2	+26.1	+9.3	20.9
Meghna Dhonagoda	+5.1	-11.4	+5.4	-6.8
Zilkar Haor	+29.4	-16.3	+15.9	-10.9
Kolabashukhali	+18.1	+12.6	+0.5	+7.7

Source : Case studies.

Table K12 Present Annual Income Per Family Labour : PIE Areas

PIE - areas	Annual Income Per Family Labour (000 Tk).											
	Rice Mill		Black Smith		Grocery/ Stationery		Rice trading		Road-transport		Boatman	
	I	C	I	C	I	C	I	C	I	C	I	C
Chalan Beel	12	58	13	20	8	10	9	43	17	11	9	23
Kurigram	84	14	51	17	14	24	24	18	13	6	7	16
Meghna Dhonagoda	40	22	17	20	79	33	48	36	21	16	10	24
Zilkar Haor	51	35	50	8	25	9	12	22	18	NA	7	9
Kolabashukhali	309	31	23	NA	13	9	21	8	NA	14	17	9

I = Impacted area
C = Control area

Source : Case studies.

K6 PERCEPTIONS OF BENEFITS FROM THE PROJECTS

The entrepreneurs engaged in non-farm activities within the Project areas, by and large, stated that they have benefited from the Projects; only people living on boat transport and fishing are exceptions. In the course of the case studies the entrepreneurs' perceptions of benefits from the projects under study were recorded. The perceptions of benefits towards

development of non-farm activities have been presented in Table K13. As can be seen from the table, the percentage of benefited entrepreneurs appears to be the highest (87 per cent) for Kurigram South, followed by 73 per cent for Meghna Dhonagoda, 70 per cent for Kolabashukhali, 53 per cent for Chalan Beel and 44 per cent for Zilkar Haor. As also can be seen from the table, the most remarkable benefit towards development of non-farm activities has been, by way of facilitating transportation of raw materials and outputs, and stimulating increased demand for outputs.

Table K13 Respondents' Perceptions of Benefits from the Project.

Type of Benefit	% of benefited respondents				
	Chalan Beel	Kurigram South	Meghna Dhonagoda	Zilkar Haor	Kolabashu-khali
Eased transportation of raw materials and output	100	46	18	100	74
Increased supply of raw materials	50	69	27	100	53
Increased demand for output	50	77	91	100	53
Others	-	-	-	43	11
Benefited respondents	8	13	11	7	14
Benefited respondents as % of total	53	87	73	47	70

Source : Case Studies.

K7 DAMAGE BY 1988 FLOOD

Table K14 gives information on type and extent of damage caused to enterprises by the 1988 flood. As can be seen from the table, for Chalan Beel Project, entrepreneurs in the impacted area appear to have suffered losses higher than than in the control area. Thus the Project appears not to have reduced the risk of damaging floods (affecting industrial property). This may be because entrepreneurs felt safe in building inside the Project area on low lands which were considered risky outside. In Kurigram Project, again flood losses (in terms of both number of enterprises and magnitude of losses) from the 1988 flood were reported to be higher in the Project area than in the control area. In Meghna Dhonagoda Project, however, the Project appears to have reduced the risk of flooding to some extent. About 53 per cent of the enterprises in the project area, as against 89 per cent in the control area suffered losses from the 1988 flood. Average loss per enterprise is Tk.3000 and Tk.5000 for project and control area respectively. In Zilkar Haor project, the 1988 flood caused more damage inside the project (Tk.4000 per enterprise) than in the control area (Tk.2400 per enterprise). In Kolabashukhali Project, about 30 per cent of the enterprises in the impacted area and about 46 per cent in the control area suffered losses to their infrastructure from the 1988 flood. Nevertheless, the extent of losses caused per enterprise is much higher in the impacted area (Tk.1400), compared to the control area (Tk.340). This again, may be because those inside the protected area had established enterprises in areas that they believed were not at risk, whereas entrepreneurs outside protected areas tended to build on higher ground in the absence of protection. It is also the case, however, that agriculturally successful projects,

simply by encouraging increased investment, will automatically tend to increase the value of losses when projects fail in exceptional years

Table K14 Damage Caused by 1988 Flood

Area	Total Sample	No. of units affected by 1988 flood	Affected units as % of total	Mean loss per enterprise[1] (Tk.) on account of					
				Structure	Machinery	Raw material	Output	Working days	Total
Chalan Beel Polder D									
Impacted	15	6	40	233	84	10	4005	1370	5702
Control	18	5	28	56	-	-	31	928	1015
Kurigram South									
Impacted	15	4	27	27	-	3	52	492	574
Control	16	3	19	-	-	-	-	163	163
Meghna Dhonagoda									
Impacted	15	8	53	703	-	1000	-	1323	3026
Control	18	16	89	1117	297	268	250	3324	5256
Zilkar Haor									
Impacted	16	11	69	2100	25	272	519	1055	3971
Control	15	9	60	753	67	740	487	387	2434
Kolabashukhali									
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. Source : Case Studies.

APPENDIX L

GENDER IMPACT

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APPENDIX L

GENDER IMPACT

L1. INTRODUCTION

L1.1 Limitations

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

L1.2 The Areas of Investigation

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

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

ii. activities related to homestead production;

iii. nutritional issues;

iv. problems faced by women during severe floods.

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

L2. NATURE OF WOMEN'S INVOLVEMENT IN HOUSEHOLD AND OUTSIDE WORK

L2.1 Hiring of Women

Households have been found to be involved in both hiring-out and hiring-in of women for employment (Table L.1). Among farm families the incidence of the former is low, and in all project-impacted areas much less than the latter (hiring-in). The finding for the control areas is similar except in cases where these are equal. At the same time one finds that, while in case of hiring-out the incidence is similar across impacted and control areas for a given project, there is a substantial difference between the two types of areas while employing in hired female hands. In three projects (MIDP, Zilkar Haor, KBK), where there have been very substantial output gains in paddy cultivation (ranging from 90 to 160 per cent), the proportions of households hiring female labour in the impacted areas are far above those in the control. In Chalan Beel where the output gain has been the least, one finds little such difference.

Generally one would expect women from labour households to work outside the home, if there is a chance to do so (as may happen if there is a demand for their services e.g. in

post-harvest processing due to output growth) or if there is a compulsion to do so (due to poverty) or both. Tradition and custom against women working outside the home, however, may not allow them fully to take advantage of the emerging opportunities or respond to the compulsion. On the other hand, unless there is a substantial level of homestead production activities one would not expect an appreciable incidence of hiring-in of women in such households. Indeed, it has been found that while in most of the projects there is generally a high incidence of women from labour households earning income for employment outside the home, there is not a single instance of hiring-in by them.

There is no systematic difference between the impacted and control areas in the incidence of hiring-out of women from labour households, nor as has been stated above does one find a high incidence in every project. For example, in Kurigram, a generally depressed area with a very high incidence of poverty among labour households (see section L4), one finds a correspondingly high incidence of women working outside the home. In MDIP, where there has been appreciable output growth in the impacted area and most of the labour households have been found to be poor, the incidence of hiring out is very low. Social custom and tradition may be a factor but without further investigation it is difficult to know about or analyse the correlating factors. Incidentally, among all the high-growth areas, the percentage of farmers in the MDIP impacted area claiming to have hired in women labourers is the lowest.

Among fishermen's households hiring-in or out of women is rare except in Kurigram. This may be due to the generally low level of economic well-being in the area.

L2.2 Agricultural vs. Non-Agricultural Work

Women in farm households are naturally involved in one or other type of agricultural work for the family. Where the households are lucky enough to own a small piece of land, women in labour and fishermen's households are also involved in such work, but this is more of an exception than a general rule.

The opposite generally holds for non-agricultural work. While very few women from farm families are engaged in non-agricultural pursuits, the number and proportions are much higher in the labour and fishermen's households (Table L.2). This is true across all projects.

One discovers one other pattern. On the whole, the relative incidence of women's involvement in non-agricultural work is higher in the control areas. This is also true for all individual projects. The pattern is very similar in the case of women from labour and fishermen's households and holds in a limited fashion also for the farm families. Without more information it is difficult to say why this is so, but it may be another indicator of positive project impact on farm output, and hence on income and employment.

L2.3 Sexual Division of Work in Agricultural Activities

Prior to the flood control measures, the women's and men's responsibilities in agricultural activities were generally clear cut. Practically all men were involved in field activities related to pre-harvest and harvest operations and women were excluded from them. (Table L.3). The women were most visible in tasks like seed preservation, drying and parboiling of paddy and to a lesser extent in threshing and husking tasks which could be performed within the household. In threshing, they shared the burden with men, but in husking, a few hired female hands were employed. Very few men were involved in

drying/parboiling or husking of paddy. These patterns were the same in both impacted and control areas.

Table L.1 Employment of Women in Activities Outside the home
(% of respondents)

Project	Activity	Farmer		Labour		Fishermen		All	
		Impacted	Control	Impacted	Control	Impacted	Control	Impacted	Control
CBPD	Hire out	8	3	26	42	0	7	11	13
	Hire in	13	10	0	0	0	0	8	5
KUR	Hire out	0	3	44	50	47	40	18	21
	Hire in	18	30	0	0	0	0	11	17
MDP	Hire out	1	0	10	0	0	7	3	2
	Hire in	17	0	0	0	0	0	10	0
ZH	Hire out	2	0	50	14	23	24	14	9
	Hire in	35	20	0	0	8	0	23	11
KBK	Hire out	3	10	13	15	0	6	5	10
	Hire in	21	10	0	0	0	0	13	5
ALL	Hire out	3	3	27	27	14	17	10	11
	Hire in	20	15	0	0	1	0	13	8

Source: FAP 12 PIE Household Survey

Table L.2 Incidence of Family Women's Involvement in Non-Agricultural Work
(No. and % of households)

Project	Farmer		Labourer		Fishermen		All	
	Impacted	Control	Impacted	Control	Impacted	Control	Impacted	Control
CBPD	9 (14)	6 (21)	11 (48)	6 (50)	4 (27)	8 (53)	24 (23)	20 (36)
KUR	1 (2)	1 (3)	9 (36)	7 (50)	9 (60)	9 (60)	19 (19)	17 (26)
MDP	2 (3)	9 (0)	3 (10)	1 (9)	3 (20)	4 (27)	8 (7)	5 (9)
ZH	11 (17)	3 (10)	5 (24)	1 (14)	9 (69)	17 (100)	25 (26)	21 (39)
KBK	9 (15)	3 (10)	7 (30)	4 (31)	2 (14)	6 (38)	18 (18)	13 (22)
ALL	32 (10)	13 (8)	35 (29)	19 (35)	27 (38)	44 (56)	94 (18)	76 (26)

Source: FAP 12 PIE Household Survey
Note: Figures in parentheses are percentages.

With the changes in agricultural output and practices due to the projects, one finds little or no change in the basic patterns. There is an exception, though. In three projects, namely Chalan Beel Polder D, Kurigram South and Zilkar Haor, there has been a diminution of the role of women and an increase in that of men in husking operations (not shown).

On probing, it has been found that in each case, both for the impacted and the control areas, mechanised husking has become more common due to the use of STW engines for the purpose during the off-seasons. In MDIP, while the control area has similar facilities, the impacted area does not as STWs are rarely used there (most irrigation is from BWDB canals). In Kolabashukhali facilities for mechanised husking are not available (due to almost complete lack of STW irrigation) and so one finds little change in the relative roles of men and women in husking in this area.

In none of the projects selected for PIE can STW irrigation be termed as an impact of the project except to a limited extent in the Zilkar Haor project, where one finds a sharper drop in the husking role of women in the impacted area compared to that in the control.

Table L.3 Sex-wise Role Distribution in Agricultural Work
(All Projects - Farm Households) (% 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 preserv.	93	92	3	4	32	29	92	93	2	3	36	36
Pre-harvest	2	2	1	1	99	99	1	2	2	1	97	97
Harvesting	1	2	20	20	97	97	1	1	21	20	95	96
Threshing	62	64	12	14	81	81	58	58	7	7	60	79
Drying/parboiling	95	95	15	17	3	3	96	77	10	10	4	4
Husking	73	56	14	7	12	25	78	66	8	8	17	37
Storage	97	98	4	8	12	12	97	97	6	7	13	13

Source: FAP 12 PIE Household Survey

Note: F. Women : Family women
H. Women : Hired women
B : Before project
A : After project (at present)

L2.4 Change in Activities of Women Family Members

L2.4.1 Change in Agricultural Activities

Over time since the implementation of the projects, two types of change may have taken place which influence the ultimate work burden of women in agricultural activities. If there is increased output, there is likely to be a greater burden on women for seed preservation, parboiling and storage in which mainly women are involved. In other activities such as threshing and husking, as men also work with women the actual work burden on

women will depend on the degree to which men share the work. As there is no *a priori* hypothesis about how the latter should be influenced by the project intervention, in such cases the actual outcome cannot be predicted.

As the project areas show similar patterns over all the projects, the information has been pooled and reproduced as Table L.4. A careful scanning leads one to the following conclusions:

- in no case is there an unambiguous increase or decrease of any activity either in the impacted or the control areas, which probably reflects the socio-economic differentiation that exists among women;

- in seed preservation comparatively more women have experienced an increased work load in both impacted and control areas, but more so in the former;

- in the case of parboiling and storage, both in the impacted and control areas the proportion of women claiming an increased work load is lower than those claiming a reduction, but the proportion claiming an increase is again higher in the impacted areas compared to the control areas;

- in the case of husking, the majority of women have indicated a lower work burden in both impacted and control areas but the proportion of women claiming a decrease is somewhat lower in the impacted areas;

- although women are generally not involved in pre-harvest operations it is interesting to note that, among those who have reported a change, most have indicated an increase in the women's work.

In none of the above cases, except for storage, is there a statistical difference in the response of women between the impacted and control areas.

The over-all conclusion that one may draw here is that in the impacted areas, because of higher production compared to the control area, the work load of women has increased, particularly in activities where women play the major role. However, none of these differences are yet pronounced as the changes are not uni-directional across all households.

L2.4.2 Reasons for Change in Agricultural Activities

Table L.5 shows the response of women from farm households when asked to identify the reasons behind the change in their involvement in farm activities. Several conclusions can be immediately drawn from their responses. The first and foremost among them is that the women's involvement changes in response to the volume of output received within the household. In the case of increased level of activities it is unambiguously and directly related to higher output from land. There is hardly any other important reason. The pattern is the same across projects and type of area (impacted or control).

Table L.4 Change in Activities of Family Women in Agricultural Operations (Farmer Households) (No. of households claiming change)

Area type	Change type	Seed pres.	Pre-harvest	Threshing	Parboiling	Husking	Storage
CHALAN BEEL POLDER D							
Impacted	Increased	22	1	6	26	2	22
	Decreased	8	0	5	12	8	5
Control	Increased	9	0	3	11	0	7
	Decreased	8	0	5	12	8	5
KURIGRAM SOUTH							
Impacted	Increased	9	1	1	11	1	11
	Decreased	10	0	7	37	27	15
Control	Increased	3	0	0	5	2	1
	Decreased	2	0	0	16	11	10
MEGHNA-DHONAGODA							
Impacted	Increased	17	0	8	40	2	25
	Decreased	8	0	2	21	13	11
Control	Increased	0	0	0	0	0	0
	Decreased	0	0	0	10	15	4
ZILKAR HAOR							
Impacted	Increased	12	0	9	18	3	12
	Decreased	9	0	10	32	18	19
Control	Increased	0	0	0	0	0	0
	Decreased	0	0	0	17	11	12
KOLABASHUKHALI							
Impacted	Increased	15	1	7	23	2	18
	Decreased	10	0	5	19	8	17
Control	Increased	1	0	0	0	0	0
	Decreased	6	0	4	24	10	18
ALL PROJECTS							
Impacted	Increased	76 (61)	3 (75)	31 (50)	118 (47)	10 (11)	88 (52)
	Decreased	46 (39)	1 (25)	30 (50)	130 (53)	74 (89)	80 (48)
Control	Increased	13 (38)	0 (-)	3 (25)	16 (16)	2 (3)	8 (14)
	Decreased	21 (62)	0 (-)	9 (75)	79 (84)	55 (97)	49 (86)

Source: FAP 12 PIE Household Survey.

Note: Figures in parentheses are percentages of the total number of respondents among the interviews. The percentages may add upto more than 100 due to multiple responses.

In the case of decreasing involvement of women, various replies have been received. However, except for those related to prevalence of husking machines, and the miscellaneous category, all others can be lumped together as these ultimately imply a lower level of output reaped/received by the household. As to the reasons behind such reduced output, two stand out prominently viz., loss due to flood and drainage congestion and loss of land. Interestingly,

the proportion of responses falling in the latter category is higher in all the impacted areas compared to the control ones. Why this should be so is not clear, due to lack of other information, but if one looks at the land-holding changes (see Appendix M), except for Meghna-Dhonagoda, there is no substantial difference in percentage of respondents in impacted and control areas experiencing a reduction in land-holding. Whether land erosion could be the ultimate reason for the land loss is not known with certainty.

Table L.5 Reasons for Change in Women's Involvement in Agricultural Activities in Farm Households (No. of response)

Reasons	CBPD		KUR		MDIP		ZH		KBK		ALL	
	Impacted	Control	Impacted	Control	Impacted	Control	Impacted	Control	Impacted	Control	Impacted	Control
A. Increase	63	23	17	8	45	-	30	1	42	3	197	35
Higher output	58 (92)	18 (78)	16 (94)	7 (88)	40 (89)	-	27 (90)	1 (100)	34 (81)	2 (67)	175 (88)	28 (80)
Others	5 (8)	5 (22)	1 (6)	1 (12)	5 (11)	-	3 (10)	-	8 (19)	1 (33)	22 (12)	7 (20)
B. Decrease	49	47	76	33	45	25	10	2	55	54	235	161
Flood/water logging/rain	17 (35)	12 (25)	13 (17)	10 (30)	5 (11)	2 (8)	10 (100)	2 (100)	12 (22)	20 (37)	57 (24)	46 (29)
Land loss	14 (28)	2 (4)	23 (30)	4 (12)	17 (38)	6 (24)	-	-	14 (25)	4 (7)	68 (29)	16 (10)
Cut in embankment	6 (12)	-	-	-	-	-	-	-	1 (2)	- (9)	7 (3)	-
More husking machines	4 (8)	2 (4)	20 (26)	5 (15)	15 (33)	12 (48)	-	-	5 (9)	5 (26)	44 (19)	24 (15)
Pest attack	2 (4)	11 (23)	-	-	-	-	-	-	7 (13)	14	9 (4)	25 (15)
Lower yield	3 (6)	8 (17)	4 (12)	4 (12)	5 (11)	4 (16)	-	-	-	-	19 (8)	16 (10)
Others	3 (6)	12 (25)	9 (12)	10 (30)	3 (7)	1 (4)	-	-	16 (29)	11 (20)	31 (13)	34 (21)

Source: FAP 12 PIE Household Survey

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

L3. HOMESTEAD PRODUCTION

L3.1 Homestead Forestry

L3.1.1 Number of trees

The households have been found to care for a large number of trees and plants in and around the homestead. Generally, it is the farm households which have quite a large number of trees while fishermen have been found to have the lowest number. Obviously, the number depends on the area of the homestead land available for tree plantation and growth. Farm households are the most fortunate in this regard as may be seen from Table L.6.

Although the numbers vary by the type of household, the trend between the pre- and post-project situations in all cases is almost uni-directional. It is clear from Table L.6 that the average number has increased in every project area, whether impacted or control, except for Zilkar Haor. Furthermore, the change is more prominent in the control than in the impacted area. In Zilkar Haor, the fall likewise is more perceptible in the control area.

Table L.6 Average Number of Trees in and Around the Homestead

Project	Farmer				Labourer				Fishermen				All			
	Impacted		Control		Impacted		Control		Impacted		Control		Impacted		Control	
	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A
CBPD	116	161 (39)	123	185 (50)	9	26 (189)	19	38 (100)	11	9 (-18)	17	35 (106)	77	108 (40)	72	113 (57)
Kurigram	83	96 (16)	61	96 (57)	28	32 (14)	4	10 (150)	25	20 (-20)	73	24 (-67)	61	69 (13)	52	61 (17)
MDIP	35	48 (37)	26	63 (142)	5	11 (120)	13	18 (138)	6	4 (-33)	4	14 (225)	24	33 (38)	17	41 (141)
Zilkar Haor	230	140 (-39)	184	91 (-51)	147	68 (-54)	85	25 (-70)	42	13 (-69)	125	67 (-46)	186	107 (-43)	153	75 (-51)
KBK	54	77 (42)	29	55 (89)	35	35 (-)	14	58 (142)	13	31 (138)	7	32 (72)	44	61 (39)	22	49 (123)

Source: FAP 12 PIE Household Survey

Note: Figures in parentheses indicate percentage change over the pre-project situation. The number of trees include bamboos.

L3.1.2 Types of Trees

Many types of trees are grown in the homesteads. The most numerous ones are mango, banana, betel nut, coconut, jackfruit, palm and bamboo. The trees can be divided into two categories, whether fruit-bearing or mainly timber-yielding. The results are shown for all the households together in Table L.7. The data clearly indicate a rise in the proportion of fruit-bearing trees in both impacted and control areas and more so in the latter. Although it is difficult to hypothesise why such changes may take place due to lack of other information, the implication of the change for women's work burden is clear. As they are the ones most involved in tree care (see below), their work burden may have increased on this count and more particularly in the control areas.

L3.1.3 Sexual Division of Work in Caring for Trees

In all the project areas, irrespective of whether they are impacted or control, and in all occupational groups, women have been found to be conspicuous in their role in collection of tree leaves, firewood, twigs etc. from the trees and also in general in tree care, particularly in association with men. However, planting of trees, harvest and tree felling are in most cases generally men's jobs. While making decisions regarding the plantation and harvesting, the decision-making appears to be more participatory, but in the case of tree-felling the decision-making is done generally by men. What all these factors mean is that while women are involved to certain extent in decision making and actually carrying out decisions, their role is

confined mostly to those activities which relate to caring for the trees. When it comes to economically more substantive decisions and activities such as planting, harvesting and tree-felling men assume more important roles (Table L.8).

Table L.7 Proportion of Fruit-Bearing and Water-resistant Trees
(% of all trees)

Project	Fruit-bearing			
	Impacted		Control	
	Before	After	Before	After
Chalan Beel Polder D	16	27	36	40
Kurigram South	42	53	42	58
Meghna-Dhonagoda	51	53	46	46
Zilkar Haor	29	32	38	42
Kolabashukhali	62	71	69	81
All	39	42	41	51

Source: FAP 12 PIE Household Survey

Note: The percentages exclude bamboo

L3.2 Vegetable Produdction

L3.2.1 Vegetable Gardens

Practically all households have a vegetable producing plot, usually quite tiny, no more than 1-2 decimals in most cases. One observes considerable differences in the size of these plots but it is difficult to discern any pattern either by project, type of area or occupational category of the household (Table L.9).

L3.2.2 Sex Roles in Vegetable Gardening

Vegetable Gardening is mainly a women's domain from planting decisions to land preparation to harvesting. Men help mostly with land preparation, sowing and weeding. In the case of sale, they are more involved.

L3.3 Poultry Keeping

L3.3.1 Sexual Division in Decisions Regarding Poultry Keeping

Women's role (whether individually or in association with men) in decision making in poultry keeping does not seem to pronounced. In general only about forty per cent of women are so involved (Table L.10). There is no consistent pattern either by project or by type of

area. However, it may be noted that in some cases the women appear to have somewhat greater decision making power in the control areas.

Table L.8 **Incidence of Women's Role in Decision Making in Tree Plantation**
(No. and % of women responding positively)

Activities	Farmer		Labourers		Fishermen		ALL	
	Impacted	Control	Impacted	Control	Impacted	Control	Impacted	Control
CHALAN BEEL POLDER D								
Plantation	36	18	9	6	3	12	48	36
Harvesting	52	26	12	8	6	15	70	49
Tree felling	22	16	6	6	1	11	29	33
KURIGRAM SOUTH								
Plantation	40	14	11	4	8	10	59	28
Harvesting	51	34	10	7	5	9	66	50
Tree felling	18	4	4	2	2	8	24	14
MEGHNA DHONAGODA								
Plantation	44	10	12	2	6	3	62	15
Harvesting	51	30	18	9	6	9	75	48
Tree felling	28	0	6	0	4	0	38	0
ZILKAR HAOR								
Plantation	46	13	13	1	2	12	61	26
Harvesting	52	24	15	6	6	13	74	43
Tree felling	24	7	6	0	2	9	32	16
KOLABASHUKHALI								
Plantation	43	22	15	7	10	8	68	37
Harvesting	52	29	18	9	11	10	81	48
Tree felling	31	7	11	5	11	6	53	18
ALL PROJECTS								
Plantation	209 (65)	77 (49)	60 (50)	20 (35)	29 40)	45 (58)	298 (58)	142 (49)
Harvesting	258 (80)	143 (92)	73 (60)	39 (68)	34 (47)	65 (72)	365 (71)	238 (82)
Tree felling	123 (38)	34 (22)	33 (27)	13 (23)	20 (28)	34 (44)	176 (34)	81 (28)

Source: FAP 12 PIE Hiusehold Survey
Note: Figures in parentheses are percentage of total number of respondents.

Table L.9 Percentage Change in Area Under Vegetable Gardens

Project	Farmer		Labourer		Fishermen	
	Impacted	Control	Impacted	Control	Impacted	Control
CBPD	-31	51	-49	-1	-29	-37
KUR	1	4	32	0	-36	85
MDIP	-8	-1	26	0	7	22
ZH	0	-66	0	18	0	-15
KBK	61	16	23	105	600	7

L3.4 Homestead Income and Its Use

L3.4.1 Homestead Income

The estimated average income per year per household from homestead activities is shown in Table L.11. Note that it was not possible to quantify income-accrual due to consumption of fruits, fuelwood and other tree products from the homestead, nor do the figures include other livestock and homestead pond income. However, an idea about these may be obtained from the relevant sections in Appendix M. Be that as it may, the figures in Table L.11 clearly indicate that in the impacted areas, the farm households may have gained substantially in terms of homestead income while other groups have not.

Lack of other related information precludes a definitive explanation for such differences, but it should be noted that women in farm households, being freed in many cases of the back-breaking job of husking, may have more time for raising poultry, which is the major source of the homestead income shown in the table. Women in non-farm households may also be similarly freed but they may have had to take up other out-of-home activities.

L3.4.2 Gender Differences in Receipt of Sale Money

Very few households sell vegetables or poultry or eggs, but whatever is sold, the proportion of women in farm households who are able to receive the cash appears to be similar to that for men (Table L.12). In labour and fishermen's households, women seem to be slightly more at an advantage. There seem to be no clear impact-control area differences.

L3.4.3 Use of Homestead Income

The income earned from homestead activities accrues mostly in kind. Much of the vegetables and eggs produced are consumed directly by the household. So are chickens and ducks. It does not come as a surprise, therefore, that the women say that they spend the income mainly for the household (Table L.13). In the farm households, however, and interestingly in the impacted areas a sizeable proportion (24 per cent) indicate that they use it for personal purposes. In the control area the proportion is almost half as much. One also finds that no woman claims to save any income, again a finding which is a direct result of income-accrual in kind (food).

Table L.10 Incidence of Women's Roles in Decision Making in Poultry Keeping
(No. and % of women responding positively)

Activities	Farmers		Labourers		Fishermen		All	
	Impacted	Control	Impacted	Control	Impacted	Control	Impacted	Control
CHALAN BEEL POLDER D								
Sale	43	21	11	5	-	11	54 (53)	37 (66)
Purchase	45	21	13	6	-	12	58 (57)	39 (70)
Use of sale money	47	22	13	4	1	10	61 (60)	36 (64)
KURIGRAM SOUTH								
Sale	25	12	6	1	5	5	36 (35)	18 (27)
Purchase	15	4	21	-	6	1	42 (41)	5 (8)
Use of sale money	29	23	11	5	7	7	47 (46)	35 (53)
MEGHNA DHONAGODA								
Sale	27	16	9	4	4	1	40 (34)	21 (38)
Purchase	24	-	5	-	2	-	31 (26)	-
Use of sale money	38	24	9	5	3	3	50 (43)	32 (57)
ZILKAR HAOR								
Sale	7	11	-	2	1	8	8 (8)	21 (39)
Purchase	34	21	3	3	3	9	40 (41)	33 (61)
Use of sale money	8	7	-	1	1	8	9 (9)	16 (30)
KOLABASHUKHALI								
Sale	33	13	10	6	8	8	51 (52)	27 (46)
Purchase	35	18	8	7	5	5	48 (49)	30 (51)
Use of sale money	35	15	11	4	10	8	56 (57)	27 (46)
ALL PROJECTS								
Sale	135 (42)	73 (47)	36 (30)	18 (32)	18 (25)	33 (42)	189 (34)	124 (43)
Purchase	153 (47)	64 (41)	50 (41)	16 (28)	16 (22)	27 (35)	219 (42)	107 (37)
Use of sale money	157 (49)	91 (58)	44 (36)	19 (33)	22 (30)	336 (46)	223 (43)	146 (50)

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

Table L.11 Returns from Homestead Production
(Average Tk./household/year)

Project	Farmer		Labourer		Fishermen	
	Impacted	Control	Impacted	Control	Impacted	Control
CBPD	1532	839	810	961	413	1014
KUR	1060	1641	436	532	265	418
MDIP	1125	883	404	469	171	310
ZH	2109	805	483	293	164	1449
KBK	1053	891	323	466	418	633
ALL	1374 (71)	1041 (78)	485 (79)	566 (83)	290 (78)	783 (77)

Source: FAP 12 PIE Household Survey.

Note: Figures in parentheses indicate percentage share of poultry and egg in total return.

Table L.12 Recipient of the Income from Vegetable Sale
(All Projects) (No. of responses)

Reciepient	Impacted			Control		
	Farmer	Labour	Fishermen	Farmer	Labour	Fishermen
Husband/Son/Father	22	4	-	15	5	1
Wife/Mother/Daughter	20	12	5	13	2	6
Both	19	2	-	10	4	3

Source: FAP 12 PIE Household Survey

Table L.13 Use of Income Earned by Women From Different Sources
(All Projects) (No. of responses)

Type of spending	Impacted			Control		
	Farmer	Labour	Fishermen	Farmer	Labour	Fishermen
Mainly for household	122	42	24	71	34	41
Mainly for personal care	40	2	5	11	3	5
Save/Others	-	-	-	-	-	-

Source: FAP 12 PIE Household Survey

L3.5 Group Activities

L3.5.1 Extent of Involvement

Very few women were found to be involved in group activities, but comparatively more were involved in the control (31 or 11 per cent) areas than in the impacted areas (39 or 7 per cent). Group activities are more important among the labour and fishermen's households (18 out of 39 in the impacted and 24 out of 31 in the control areas). NGO groups/cooperatives seem to be quite important among the farmers in the impacted areas in Chalan Beel and Kolabashukhali Projects. Such groups were found also among the fishermen in the control area of Chalan Beel.

Most of the group activities are of recent origin (having started about 3 years back) in both impacted and control areas.

L4. NUTRITIONAL ISSUES

L4.1 Caveats

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

The four types of food mentioned above contribute nearly 84 per cent of total calorie intake (BBS; 1991) in rural Bangladesh. Using this ratio, the total calorie consumption in the sampled households was estimated, as also was protein consumption. It should be noted that the timing of the field work for these investigations may have resulted in seasonal biases in the estimates. Zilkar Haor is mainly a Boro paddy area and the field work there coincided with the latter part of the harvest period. To some extent in the case of Meghna-Dhonagoda, the field work coincided with the generally lean month. In Kurigram, the field work coincided with the sudden inflow of flood water and lack of employment among the working classes. Possibly only in Chalan Beel and KBK could one think of average normal conditions during the field work. While within any given project, the impact-control area differences will still apply, clearly no single project data can represent the national average picture. To get an average picture one would have to pool the data from all the project areas. With these caveats we turn to the estimates.

L4.2 Food and Calorie Intake

Table L.14 shows the estimated average rice consumption and calorie intakes per capita per day in the sample households with women respondents. Several conclusions can be made on the basis of information in the table. These are

- generally, the farmers and the fishermen's households are better-off than labour households in terms of rice consumption and calorie intake;

- there appears to be no clear difference either in terms of direction or magnitude between impacted and control areas for any occupational group and

project. Indeed, in the case of the most successful project, Zilkar Haor, the per capita consumptions of rice and calories are both higher in the control areas than in the impacted.

These results do indicate that there is more to nutritional well-being than just the consumption of rice and other food and as a consequence there is not likely to be any clear correspondence between project investment and nutritional status of the people benefited/affected.

Table L.14 Per Capita Daily Rice and Calorie Intake in Sample Households

Project	Intake	Farmer		Labourer		Fishermen		All	
		Impacted	Control	Impacted	Control	Impacted	Control	Impacted	Control
CBPD	Rice (gm)	580	490	492	450	589	511	566	491
	K cal	3110	2887	3185	2271	3023	2995	3032	2731
KUR	Rice (gm)	467	519	341	299	379	450	428	467
	K cal	2198	2395	1573	1472	1857	2174	2017	2187
MDIP	Rice (gm)	457	376	345	260	437	362	430	352
	K cal	2100	1692	1609	1114	1865	1609	1963	1569
ZH	Rice (gm)	540	671	450	690	607	607	534	653
	K cal	2801	3209	2651	3252	2976	3578	2798	3330
KBK	Rice (gm)	573	527	429	427	424	427	521	480
	K cal	2766	2671	2146	2432	2246	2438	2562	2560
ALL	Rice (gm)	524	523	406	399	485	480	497	492
	K cal	2606	2538	2107	1984	2361	2648	2479	2479

Source: FAP 12 PIE Household Survey.

L4.3 Poverty Profile

The estimated calorie consumptions were used to construct a profile of households on the basis of attainment of certain level of calorie intake. The households were divided into three groups, viz., those categorised as hard core poor (consuming at most 1805 K cal/person/day), absolute poor (consuming between 1805 and 2122 K cal/person/day) and the non-poor (consuming above 2122 K cal). The results are shown in Table L.15.

For all the projects and all the households together just about a quarter of the households can be categorised as hard core poor. This compares favourably with the most recent BBS (BBS:1991) estimate of 28 per cent. About half as many can be said to be in absolute poverty. The most important finding of course, is that about 60 per cent or so of the rural households can be termed as non-poor. The proportion of the non poor is the highest among the farmers(70 per cent) and the lowest (40 per cent) among the labour households. There is no clear pattern of impacted-control area differences.

Between projects, one finds no clear pattern of difference by type of area either for farmers or for any other group or for all respondents together. Most interestingly, one finds

that the proportion of the non-poor is the highest in CBPD and it is so even among the fishermen. Quite predictably Kurigram has a low percentage of non-poor, around 45 per cent, but the project with the lowest proportion of non-poor is MDIP where production increase has been greatest (see Appendix H). The only redeeming feature of this bleak situation in MDIP is that the non-poor are much more numerous in the impacted area than in the control. The absence of the project would in such a case have meant even more misery for the people in the impacted area in MDIP.

Table L.15 Distribution of Households by Level of Nutritional Poverty
(No. of households)

Project	Occupation group	Hard core		Absolute		Non-poor		All	
		Impacted	Control	Impacted	Control	Impacted	Control	Impacted	Control
CBPD	Farmer	0	2	2	3	62	24	64	29
	Labour	6	4	1	0	16	8	23	12
	F.men	2	0	0	1	13	14	15	15
	All	8	6	3	4	91 (89)	46 (82)	102	56
KUR	Farmer	14	9	16	8	32	20	62	37
	Labour	13	8	8	3	4	3	25	14
	F.men	6	4	2	3	7	8	15	15
	All	33	21	26	14	43 (42)	31 (47)	102	66
MDIP	Farmer	26	14	11	9	35	7	72	30
	Labour	19	11	8	0	3	0	30	11
	F.men	8	12	3	2	4	1	15	15
	All	53	37	22	11	42 (38)	8 (14)	117	56
ZH	Farmer	10	1	5	4	49	22	64	27
	Labour	7	0	2	0	12	7	21	7
	F.men	0	0	1	0	12	17	13	17
	All	17	1	8	4	73 (74)	49 (91)	98	54
KBK	Farmer	5	1	4	7	52	25	61	33
	Labour	7	4	3	2	13	7	23	13
	F.men	3	2	4	5	8	8	15	15
	All	15	7	11	14	73 (75)	37 (64)	99	48
ALL	Farmer	55 (17)	27 (17)	38 (12)	31 (20)	230 (71)	98 (63)	323	156
	Labour	52 (43)	27 (47)	22 (18)	5 (9)	48 (39)	25 (44)	122	57
	F.men	19 (26)	18 (23)	10 (14)	11 (14)	44 (60)	48 (62)	73	77
	All	126 (24)	72 (25)	70 (14)	47 (16)	322 (62)	171 (59)	518	290

Source: FAP 12 PIE Household survey.
Note: Figures in parentheses represent percentage of total number of respondent household.

L4.4 Adequacy of Food Intake

The women respondents were asked about the adequacy of the intake of food in the family. The answers reported in Table L.16 show that (i) there is no systematic difference between the impacted and control area, (ii) no appreciable difference among projects (except perhaps between others and Kurigram which reports the maximum incidence of inadequacy) and that (iii) the labour households appear to be the most disadvantaged group.

L4.5 Gender Differences in Food Intake

Two indicators of gender-difference were used, viz., the difference in rice intake of adult men and women and that between boys and girls of about 8 years of age. The latter showed little difference in the food intake which mostly hovered around 5-6 *chhataks* (290-350 grams). In contrast one finds an appreciable difference between the intake of adult men and adult women who have been found to consume about 25-30 per cent less than men. There is little variation between impacted and control areas within projects or between projects.

Table L.16 Adequacy of and Gender Differences in Food Intake

Indicators	Project	Farmer		Labourer		Fishermen	
		Impacted	Control	Impacted	Control	Impacted	Control
Percentage of respondents stating inadequacy	CBPD	16	17	61	42	33	20
	KUR	44	19	92	100	80	67
	MD	25	37	87	100	53	33
	ZH	31	20	76	57	7	58
	KBK	13	33	83	85	33	27
	ALL	26	26	81	79	43	42
Women/men ratio in rice intake (%)	CBPD	79	75	76	89	79	81
	KUR	72	75	65	72	74	69
	MD	78	84	73	79	80	82
	ZH	77	80	78	81	75	80
	KBK	75	73	72	70	69	74

Source: FAP 12 PIE Surveys

L4.6 Consumption of Non-grain Food

One would expect that the consumption of non-grain food would increase in the impacted areas if there is a considerable rise in income in such places as the income-elasticity of such types of food is high (Asaduzzaman: 1989). To test the hypothesis in a simple manner the women respondents were queried about the last incidence of consumption of meat (any type), fish (any type), eggs and milk. As the general findings are broadly similar across projects, these are pooled together and reproduced here as Table L.17. Several conclusions may be drawn. These are:

- fish appears to be, as may be expected, the most frequently consumed non-grain food. Nearly all among the farmers and fishermen had eaten fish during the week preceding the survey. Among labour households, however, the proportion is much lower, around 70 per cent;

- the incidence of consumption of other types of food is much lower (except perhaps for milk);

- In general and most noticeably in case of meat there appears to be a difference between the impacted and control areas in favour of the former.

Thus on the whole the food consumption in the impacted area appears to be more balanced.

Table L.17 Incidence of Consumption of Non-grain Food During the Last 7 Days (All Projects)

Food type	Farmer		Labourer		Fishermen	
	Impacted	Control	Impacted	Control	Impacted	Control
Meat	118 (36)	32 (20)	15 (12)	4 (7)	11 (15)	11 (14)
Fish	291 (90)	142 (91)	87 (72)	39 (68)	72 (100)	75 (96)
Egg	103 (32)	52 (33)	23 (19)	5 (9)	18 (25)	18 (23)
Milk	149 (46)	66 (42)	10 (8)	7 (12)	24 (33)	24 (31)

Source: FAP 12 PIE Household Survey.

Note: Figures in parentheses are percentage of total response.

L4.7 Frequency of Cooking

Frequency of cooking can be an important indicator of nutritional status as eating cold meals or uncooked food may lead to disease and morbidity. It has been found that except in the case of Meghna-Dhonagoda, in no project is this a problem. Sixteen farm households (22 per cent), thirteen labour households (43 per cent) and 4 fishermen's households (out of 15) were found to cook only once a day. However, it must be noted that the MDIP field work was conducted during the full monsoon season when cooking becomes difficult either due to lack of dry open space (as many households lack kitchens, particularly the poor) or dry fuel. Thus MDIP findings on frequency of cooking may not necessarily indicate a lower nutritional status.

L4.8 Starvation and Adjustment Mechanisms

Despite a growth in annual income, people may still starve partly or fully during a part of the year because of seasonal lack of employment and income. When asked about such incidence, the responses seems to indicate that there had been little change in the proportion of households so affected before and after the project, irrespective of impacted or control areas, for any specific occupational group (Table L.19). Among the occupation groups, however, as may be expected the farmers are the most fortunate while most of the labourer households have to starve during parts of the year.

Table L.18 Incidence of Starvation Before and After the Project
(No. of response)

Project	Period	Farmer		Labourer		Fishermen		ALL	
		Impacted	Control	Impacted	Control	Impacted	Control	Impacted	Control
CBPD	Before	37	16	22	10	13	9	72	35
	After	36	17	20	9	12	8	68	34
KUR	Before	36	16	17	12	15	14	68	42
	After	45	20	18	12	15	15	78	47
MDIP	Before	40	17	25	8	11	14	76	39
	After	38	19	29	8	10	15	77	42
ZH	Before	44	21	18	7	9	17	71	45
	After	47	26	19	7	9	17	75	50
KBK	Before	26	17	21	9	7	6	54	32
	After	33	19	22	11	9	10	65	40
ALL	Before	183 (57)	87 (56)	103 (85)	46 (81)	55 (76)	60 (77)	341 (66)	193 (66)
	After	199 (62)	101 (65)	108 (89)	47 (82)	55 (76)	65 (83)	362 (70)	213 (74)

Source: FAP 12 PIE Household Survey.

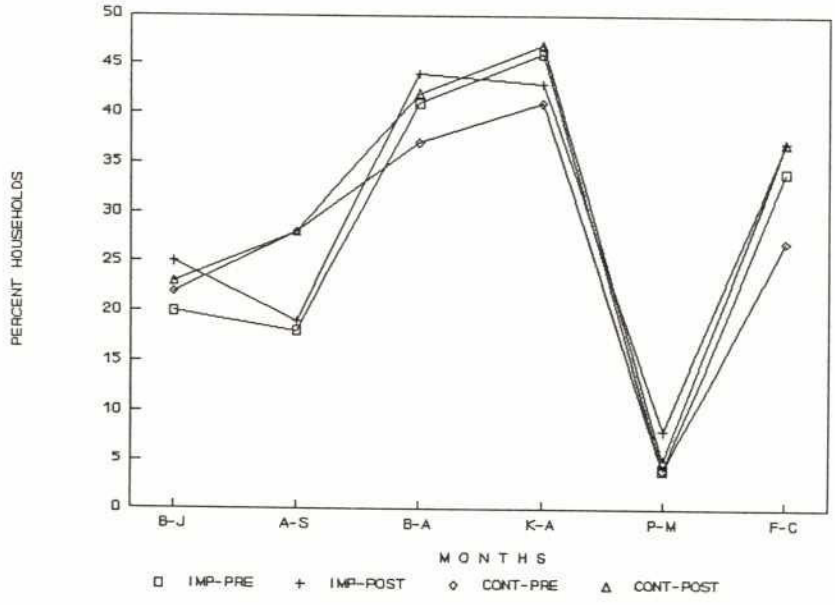
Note: Figure in parentheses are percentages of total incidence.

L4.9 Seasonality in Starvation

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

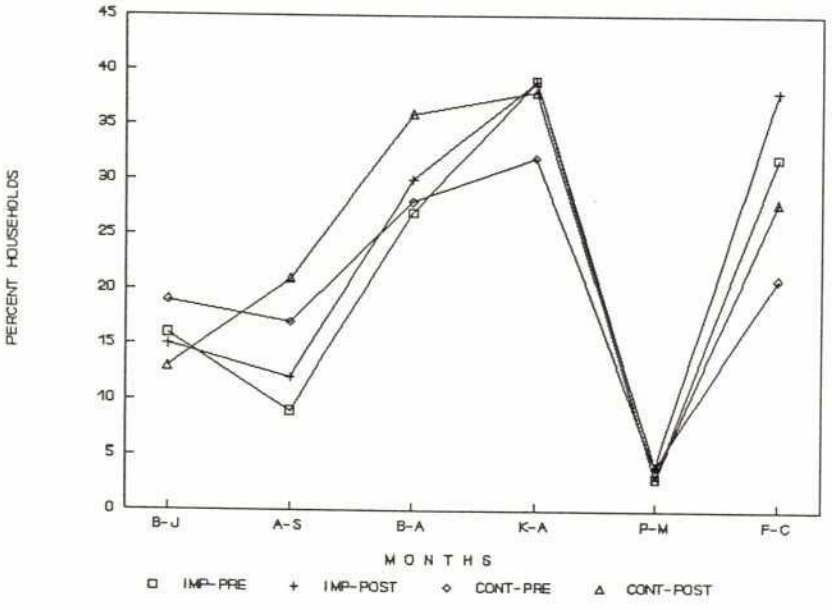
These basic hypotheses regarding seasonality are confirmed well if one looks at the combined incidence from all project areas over all types of households (Fig. L.1). Although in both impacted and control areas it appears that the incidence of starvation has increased compared to the pre-project period, the differences do not appear to be substantial.

Figure L.1 Starvation in Project Areas (All Households)



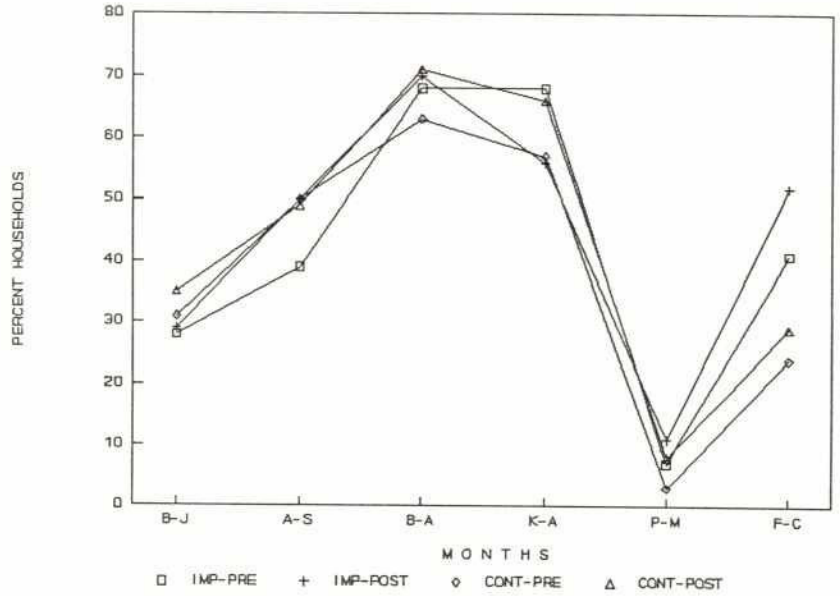
Note: B-J Baishakh-Jaishtha; A-S Ashar-Sravan; B-A Bhadra-Ashwin; K-A Kartik-Agrahayan; P-M Poush-Magh; F-C Falgun-Chaitra.

Figure L.2 Starvation in Project Areas (All Farmers)



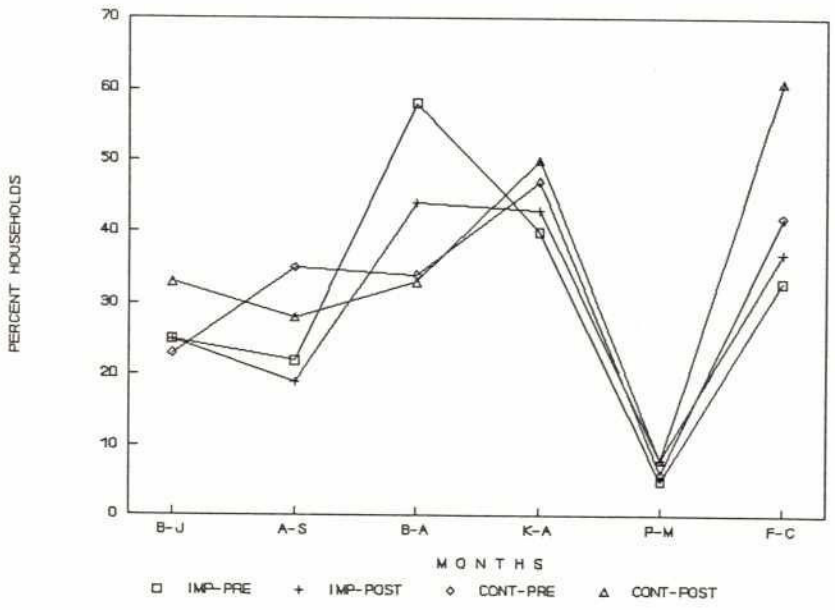
Note: B-J Baishakh-Jaishtha; A-S Ashar-Sravan; B-A Bhadra-Ashwin; K-A Kartik-Agrahayan; P-M Poush-Magh; F-C Falgun-Chaitra.

Figure L.3 Starvation in Project Areas (All Labourers)



Note: B-J Baishakh-Jaishtha; A-S Ashar-Sravan; B-A Bhadra-Ashwin; K-A Kartik-Agrahayan; P-M Poush-Magh; F-C Falgun-Chaitra.

Figure L.4 Starvation in Project Areas (All Fishermen)



Note: B-J Baishakh-Jaishtha; A-S Ashar-Sravan; B-A Bhadra-Ashwin; K-A Kartik-Agrahayan; P-M Poush-Magh; F-C Falgun-Chaitra.

Considering the occupational groups separately reveals some interesting differences from the aggregate picture although the basic pattern remains unaltered. Fig. L.2 shows that the dip during Aman harvest is the same as for the over-all pattern but the situation is not the same in the aftermath of the Boro season. While for the farmers in the impacted areas the incidence of starvation falls, for those in the control areas it begins to rise. Then again the incidence of starvation is somewhat higher for the control group. The pre-monsoon dip is the strongest in case of Zilkar Haor, MDIP and Kurigram where Boro paddy is an important crop (not shown).

While for the farmers the impact of Boro harvest lasts for a few months, for the labourers the time is shorter and the incidence of starvation rises right after summer (Figure L.3). There is little difference between the impacted and control areas either in the level or pattern of starvation.

For fishermen, the situation is the most site-specific as a result of which one finds an unclear seasonal pattern (Fig. L.4). In most cases, during the monsoon the catch is low and demand is also low due to lack of income/employment. However, in the case of MDIP, the River Meghna is a major fishing ground during the monsoon, particularly for catching hilsa, and one finds a much lower incidence of starvation here during the monsoon than in other cases for both impacted and control area fishermen.

L4.10 Adjustment Mechanisms

To avoid starvation, people seem to take four broad types of action. They borrow in cash or kind from others, or eat less, or sell off assets, or take a wide variety of other measures. The first two are the most common types of response. While nearly a third or so of the responses fall in the first-group, nearly one-half can be categorised as of the second type. The pattern is similar across occupational groups, projects or type of area (impacted or control). Disinvestment of assets is much less common.

Starvation places an unequal burden on women. In many households all the members eat less (30 per cent of response) but in a significant proportion of households only women eat less and this percentage is higher in the control areas across all occupation groups. One also observes that the apparent chance of women eating less is higher among the farmers than in other occupational groups. It may be that as women from other types of household earn an income of their own they can lay a better claim on the available food, whereas in the farm households women may not have much income of their own and thus have to bear greater suffering due to hunger.

L4.11 Access to Safe Water

While food consumption determines the extent of calorie intake, the actual utilisation of calories depends, among other factors, on various physiological conditions including disease. A major cause of disease in the rural areas is the inadequacy of sources of safe drinking water. Flood control embankments, as discussed in Appendix N, have often created problems of water pollution. Women therefore were asked about the sources of water they use, the changes in quality that may have occurred, and the associated changes in incidence of diseases.

Table L.19 Measures to Cope With Starvation
(All Projects) (No. of response)

Type of measures	Farmer		Labourer		Fishermen		All	
	Impacted	Control	Impacted	Control	Impacted	Control	Impacted	Control
Borrowing	138 (31)	81 (35)	81 (31)	43 (35)	45 (38)	49 (36)	264 (32)	173 (35)
All ate less	119 (27)	58 (25)	97 (38)	45 (37)	44 (37)	41 (30)	260 (32)	144 (29)
Women ate less	82 (19)	53 (23)	27 (10)	16 (13)	16 (13)	25 (18)	125 (15)	94 (19)
Others ate less	9 (2)	5 (2)	4 (2)	5 (4)	3 (2)	3 (2)	16 (2)	13 (3)
Disinvestment	46 (10)	26 (11)	16 (6)	3 (2)	5 (4)	4 (3)	67 (8)	33 (7)
Others	49 (11)	10 (4)	33 (13)	11 (9)	6 (5)	14 (10)	88 (11)	35 (7)

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

Table L.20 shows the pattern by source and by type of use. As all project areas and all occupational groups show similar patterns the information has been aggregated. The table clearly indicates that in the case of drinking water most households now depend on hand tubewells. Pucca wells, the other source of fair quality water, are now very rare. In fact during field work the consultants came across a well nearly a hundred years old and recently abandoned in favour of hand tubewells. Further, very few villages were found without at least one hand pump. In most cases, there were several.

What is disturbing, however, is the widespread use of open surface water for cooking and cleaning purposes. If utensils are cleaned with pond or river water, it is practically of no use to drink tubewell water. Also, in the case of cooking with open surface water, bacteria may be killed during the process but other pollutants will remain. Thus, on the whole, the households cannot be said to have good access to safe water.

The impacted and control areas have very similar characteristics at present. However, it appears that in the impacted areas the tubewell for drinking water may have spread faster. In the impacted areas, in the pre-project situation 65 per cent of households had access to tubewell water. Now it is 84 per cent. In the control area the respective figures are 75 per cent and 87 per cent. The impacted areas have thus recovered their original disadvantage, which may be due to the fact that several of the impacted areas were relatively isolated and economically depressed pre-project.

Table L.20 Present Sources of Water by Type of Use
(All Projects) (No. of response)

Use	Area	Tubewell	Pucca well	Kutcha well	Open surface water	All
Cleaning	Impacted	103 (20)	11 (2)	4 (1)	394 (77)	512
	Control	61 (21)	5 (2)	1 (-)	226 (77)	293
Cooking	Impacted	219 (43)	15 (3)	5 (1)	274 (54)	513
	Control	132 (45)	4 (1)	- (-)	157 (53)	293
Drinking	Impacted	430 (84)	11 (2)	4 (1)	68 (13)	513
	Control	255 (87)	3 (1)	- (-)	35 (12)	293

Source: FAP 12 PIE Household Survey

Note: Figures in parentheses are percentage of total response.

L4.12 Problems of Water Quality and Associated Changes

Women readily pointed out the changes in water quality observed by them and the problems due to the decrease in quality. Nearly two-thirds of them noticed a change in physical quality in both impacted and control areas (Table L.22) and pointed to the high incidence of diseases (in a quarter or more cases). Other problems were minor in significance.

Gastro-enteric diseases are more common than all other diseases both in the impacted and control areas but are less frequent in the former when the incidence per household is considered (Table L.23). In fact, except for the miscellaneous category, the incidence per household of all other diseases is somewhat lower in the impacted areas than in the control areas, both for adults and minors.

L5 PROBLEMS FACED BY WOMEN DURING FLOODS

Women were asked questions on the problems of the household due to floods, and which ones affected women most adversely. The replies given by them as reproduced in Table L.24 indicate the types of major problems faced by women. These are: lack of dry space; problem of drinking water availability; toilet facilities; food availability and cooking (presumably due to problems of dry space, water availability and of fuel); and movement. Homelessness has been cited as a major problem only in the Meghna-Dhonagoda area. There appear to be no consistent impact-control differences in the response of women to the identification of their problems, nor is there any such distinction between occupational groups (for which reason the answers have been grouped together).

Table L.21 Increase in Problems Related to Water Quality (All projects/all groups)
(No. of response)

Type of Problem	Impacted	Control
Cleaning	62 (12)	35 (12)
Physical quality	322 (63)	195 (67)
Disease	143 (28)	72 (24)
Others	61 (12)	81 (27)

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

Table L.22 Incidence of Disease by Type
(No. of cases)

Type of disease	Impacted		Control	
	Adults	Minors	Adults	Minor
Gastro-enteric	167 (0.33)	181 (0.35)	129 (0.44)	142 (0.48)
Skin	57 (0.11)	53 (0.10)	48 (0.16)	46 (0.16)
Fever	108 (0.21)	105 (0.20)	92 (0.31)	81 (0.28)
Others	33 (0.06)	57 (0.11)	14 (0.05)	25 (0.08)

Source : FAP 12 PIE Household Survey.
Note: Figures in parentheses indicate no. of cases per household.

Table L.23 Problems Faced by Women During Floods
(% of respondent)

Types of problems	CBPD		KUR		MDIP		ZH		KBK	
	Impacted	Control	Impacted	Control	Impacted	Control	Impacted	Control	Impacted	Control
Dry space	19	7	28	23	52	80	65	46	17	34
Dry water	28	25	22	14	9	14	41	37	22	40
Toilet	39	14	42	20	69	52	59	68	32	52
Cooking	19	4	30	21	56	59	62	43	31	40
Food	12	5	6	7	8	12	10	22	11	19
Movement	1	0	13	5	50	20	4	0	13	16
Homelessness	1	2	0	0	0	23	0	0	1	3
No problem	1	0	11	23	56	30	36	39	37	17

Source : FAP 12 PIE Household Survey.
Note : The same respondents may have given more than one answer.

APPENDIX M

SOCIO-ECONOMIC IMPACTS

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APPENDIX M

SOCIO-ECONOMIC IMPACTS

M.1 BACKGROUND

This appendix concentrates on a comparative assessment of the "socio-economic" impacts of the PIE Projects, with additional information gathered from the RRAs. It is largely concerned with economic impacts at the household level; thus other technical appendices examine in detail the impacts on agriculture, livestock, fisheries and economic impact, but from either a specific subject area or project level perspective. The socio-economic impacts are the ultimate impacts, if any, of FCD/I projects on their inhabitants. Hence, the concern of socio-economic evaluation is with the economic wellbeing of households in the project affected area compared with what it would otherwise have been, and with the distributional impacts on relative welfare of different categories of household. The focus is households, rather than individuals, for most of the appendix, although there is some discussion of employment impacts, and the opinions expressed in the PIE surveys are those of household heads. Appendix L has already discussed the gender implications of the Projects and so impacts on women and the problems of differential impacts of projects within the household are not discussed in this appendix, even though these are important potential socio-economic impacts.

The projects studied generally had no explicit objectives related to social development or income distribution targets. There has been a general belief that increased agricultural production in FCD/I projects, and hence increased employment and incomes, would result in socio-economic benefits. In the EIP projects there were explicit distributional aims - to benefit smaller farmers - and this culminated in Polder 17/2 where the closure was designed to eliminate shrimp farming which was regarded as a social evil, and a project with a modest anticipated economic return was taken up for distributional/social reasons.

The evaluations show that social impacts varied between projects. In some projects there are clear positive socio-economic impacts while in other cases there was negligible impact or new problems have arisen. This Appendix starts with descriptive background data on the households surveyed in the PIEs, which is of relevance not only to the main random samples of farming and non-cultivating households, but also to the case study surveys of fishermen and other occupations.

M.2 DEMOGRAPHIC CHARACTERISTICS OF THE HOUSEHOLDS

M.2.1 Age and Sex of the Household Head

Household heads, in general, appear to be in their forties. Farmers are slightly older than the other categories. There seems to be little difference in the average age of the household heads in the impacted and control areas.

Practically all households are headed by men irrespective of the broad occupational category or the area they come from. In all the study areas together, the number of female-headed households in the impacted areas is just seven out of over a thousand households. However, in Bangladeshi society farmers are virtually never female so most of the sampled

households could not have had female heads (particularly when males absent working away from the homestead for part or all of the year are treated as being the household head). Hence, only 353 households out of the main sample (the non-cultivators) could have had female heads. Even so, an incidence of two per cent is notably low compared with the national average which is 15 per cent.

M.2.2 Family Size

The average family size varies between about 5 and 8 (Table M.1). In general the labour households are smaller (consistently smaller than the respective farm household samples in each Project), while the upper range of family sizes are in the farming and case study samples. In general, the variation in family size between project areas appears to be much less among the farm households than in the other types of household.

Table M.1 Average Family Size in Project and Control Areas

Project	Farmer		Labourer		Fishermen		Others	
	Imp	Cnt	Imp	Cnt	Imp	Cnt	Imp	Cnt
Chalan Beel	6.4	5.7	4.8	3.9	5.4	6.9	5.6	3.6
Kurigram	6.2	7.0	4.7	5.5	5.6	4.8	6.6	7.6
MDIP	6.7	6.3	5.9	5.9	6.9	6.4	5.5	6.6
Zilkar Haor	8.8	7.4	6.2	6.2	6.8	7.5	7.1	7.6
KBK	6.7	6.4	5.5	4.9	7.1	6.7	6.8	5.3
All	7.0	6.6	5.4	5.3	6.4	6.4	6.4	6.1

Source: PIE Surveys

M.2.3 Sex ratio

The sex ratios in the sample households appear similar to what one would expect, a general predominance of males over females (Table M.2) reflecting preferential treatment of male children. It may be noted, however, that while in the farm households the sex-ratio is generally around 110 (number of males per 100 females), in the other household types (generally smaller samples) there are some locations where the ratio falls below 100. There appears to be no pattern between project and control areas or according to the absence or presence of impact.

M.2.4 Dependency ratio

The dependency ratio is defined as the number of family members per earner. The estimated ratios reported in Table M.3 indicate little variation around the overall mean of 4.1:1 across all PIE projects, broad occupational groups and the area type. In the case of farm households the ratio in the impacted areas is somewhat higher than in the control areas (with the exception of Kurigram South), but it seems unlikely that any increase in incomes in the Project areas would have induced households to keep children at school for longer.

Table M.2 Sex Ratios in Project and Control Areas

Project	Farmer		Labourer		Fishermen		Others	
	Imp	Cnt	Imp	Cnt	Imp	Cnt	Imp	Cnt
Chalan Beel	100	110	110	114	113	81	131	123
Kurigram	114	113	117	104	115	140	130	89
MDIP	115	115	113	125	126	108	121	119
Zilkar Haor	105	131	98	94	100	97	97	117
KBK	112	119	100	90	80	113	123	112

Source: PIE Surveys

Table M.3 Dependency Ratios by Project and Type of Household

Project	Farmer		Labourer		Fishermen		Others	
	Imp.	Cont.	Imp.	Cont.	Imp.	Cont.	Imp.	Cont.
Chalan Beel	4.2	3.6	3.5	2.9	3.2	3.5	2.4	2.2
Kurigram	4.0	4.2	3.6	4.0	3.7	3.0	4.6	3.9
MDIP	4.5	3.8	4.1	4.3	3.6	5.0	3.5	4.7
Zilkar Haor	4.2	3.4	4.0	4.0	3.8	3.4	3.6	3.7
KBK	3.9	3.8	4.0	3.6	4.1	3.5	3.8	6.5
All	4.2	3.8	3.8	3.8	3.7	3.6	3.3	3.9

Source: PIE Surveys

M.2.5 Educational Characteristics of the Household Heads

There is no consistent pattern in the level of literacy claimed for the heads of the household either by the project or by the type of area within a project (Table M.4). However, it is clear that the non-cultivating (labouring) heads of household are substantially less literate than all other categories. The farmers and the 'other' category household heads (businessmen) have proportionately more literate heads than the other categories (and are relatively wealthier).

M.2.6 School Enrolment

The increased income levels and awareness of the value of education should lead to higher enrolment of school age boys and girls into educational institutions in the project areas compared to that in the control areas. The figures in Table M.5 show a lack of any systematic difference in school enrolment between project and control areas, although in general again it is the labour households which have reported the lowest enrolments. It is possible that the

higher enrolment of boys in four out of five PIE Projects (compared with contol areas) reflects higher incomes for at least some labouring households. Within the main farmer sample there is consistently higher enrolment of boys compared with girls, but in the other occupation categories there is no conclusive evidence of any sexual discrimination in schooling.

Table M.4 Percentage of Literate Household Heads

Project	Farmer		Labourer		Fishermen		Others	
	Imp	Cnt	Imp	Cnt	Imp	Cnt	Imp	Cnt
Chalan Beel	69	55	26	8	53	73	65	78
Kurigram	62	63	19	25	53	33	47	69
MDIP	56	55	25	21	40	47	67	78
Zilkar Haor	42	26	17	13	31	7	55	53
KBK	57	52	35	29	53	13	67	69

Source: PIE Surveys

Table M.5 Percentages of Children Attending School

Project	Farmer		Labourer		Fishermen		Others	
	Imp	Cnt	Imp	Cnt	Imp	Cnt	Imp	Cnt
BOYS								
Chalan Beel	86	79	66	50	42	100	89	93
Kurigram	90	78	40	40	55	10	77	85
MDIP	81	66	65	24	54	53	63	83
Zilkar Haor	58	68	22	38	34	29	53	84
KBK	84	92	56	46	100	84	83	53
GIRLS								
Chalan Beel	76	58	26	57	24	95	85	74
Kurigram	77	76	24	11	55	65	84	76
MDIP	77	58	75	21	38	57	88	84
Zilkar Haor	53	53	33	15	38	10	67	78
KBK	76	80	55	63	62	54	68	100

Note: The percentages are derived by dividing number of school going children by number of boys and girls of school going age (6 to 15 years).

Source: PIE Surveys

M.3 OCCUPATIONS AND EMPLOYMENT

M.3.1 Primary and Secondary Occupations

The households were sampled after their categorisation in four broad groups depending on the major source of income of the household. However, many households are likely to have other sources of income. It is also very likely that not all of the family members earning an income will have the same primary occupation. An indication of the diverse income sources and multiple occupations of households is given by the following indicators: the average number of earners in the households, the incidence of secondary occupation among the heads of households, and the distribution of earners according to their primary and secondary occupations.

The estimated average number of earners per household is less than two in most cases (Table M.6) and is in general lower for the impacted than for the control areas in the case of farmers and fishermen (except in one project area in both cases). No such pattern is discernable in the other two groups, but there is unlikely to be any project related impact. However, it is also clear that the non-farm (labour) households have consistently fewer earners than do farmers. Hence for this reason alone they are likely to have less diverse incomes (despite similar dependency ratios).

Table M.6 Number of Earners by Project and Type of Household

Project	Farmer		Labourer		Fishermen		Others	
	Impacted	Control	Impacted	Control	Impacted	Control	Impacted	Control
Chalan Beel	1.53	1.57	1.37	1.33	1.71	2.00	2.36	1.61
Kurigram	1.55	1.67	1.29	1.38	1.53	1.60	1.43	1.93
MDIP	1.48	1.67	1.44	1.38	1.93	1.27	1.57	1.39
Zilkar Haor	2.07	2.17	1.54	1.56	1.81	2.10	2.00	2.07
KBK	1.74	1.71	1.38	1.38	1.73	1.93	1.78	0.81
All	1.68	1.75	1.40	1.40	1.75	1.80	1.96	1.55

Source: PIE Surveys

Table M.7 shows the estimated incidence of secondary occupation among the heads of households. Again there appears to be no clear pattern of any project impact. However, it is clear that there is a substantial degree of involvement in secondary occupations in most areas. Moreover farmers consistently have a greater incidence of secondary occupations than labouring households across all areas, and this has a direct bearing on the income differences discussed in Section M.4.

Occupational diversity will be most important where there is more than one primary occupation in a household. Table M.8a clearly shows the existence of more than one primary occupation within the same household in a minority of households. In general such incidence is the highest in case of the various non-farm households. There appears to be no definitive impacted-control area difference.

Table M.7 **Incidence of Secondary Occupations among Household Heads** (percentage of heads with a secondary occupation)

Project	Farmer		Labourer		Fishermen		Others	
	Imp	Cnt	Imp	Cnt	Imp	Cnt	Imp	Cnt
Chalan Beel	48	53	28	8	14	27	36	55
Kurigram	61	25	46	12	13	7	43	33
MDIP	36	63	14	42	33	20	36	56
Zilkar Haor	23	19	15	9	6	0	100	100
KBK	37	41	24	25	67	60	33	44

Source: PIE Surveys

Table M.8b shows the incidence of secondary occupations among all earners. Again the farming households and 'others' (households with businesses) tend to have more secondary occupations, but there is no systematic difference between project and control areas.

As regards types of occupation involved, the survey data indicate that there is a similarity across projects. There is a very low incidence of earners from non-fisherman households being involved in fishing activities either as primary or secondary occupations. Across all the projects farmers are involved in secondary occupations such as labour in the control areas and non-farm activities in the impacted areas. In contrast, labour households in both impacted and control areas, if they are lucky, can get only other types of wage labour and sometimes are engaged in non-farm activities. In Zilkar Haor, Kurigram and MDIP fishermen hardly have any second occupations, while in Chalan Beel they take second jobs mostly as wage labourers, and in Kolabashukhali some of them are also fortunate enough to own some land and farm as a second occupation.

Hence the surveys show that:

- there is a fairly high incidence of secondary occupations;
- except in a few cases, there is little to distinguish between impacted and control areas;
- the greatest concentration of secondary occupations is in non-farm activities and to a lesser extent in wage-labour (except that the 'other' businessmen also often farm); and
- fishing appears to be the least attractive other occupation.

M.3.2 Occupational Changes

There have been relatively few changes in the occupations of either household heads or all earners in the surveyed households since the dates of project completion. This is partly a reflection of the samples concentrating on farmers and labourers which are the groups least

Table M.8a Incidence of Primary Occupations Other than the Major Sources of Income of Household Among Earners.

Project	Farmer		Labourer		Fishermen		Others	
	Impacted	Control	Impacted	Control	Impacted	Control	Impacted	Control
Chalan Beel	6 (3)	3 (3)	3 (5)	5 (16)	3 (12)	7 (23)	9 (27)	9 (21)
Kurigram	5 (3)	5 (5)	8 (13)	2 (6)	4 (17)	5 (21)	4 (20)	5 (17)
MDIP	23 (13)	10 (10)	4 (6)	3 (9)	0 (-)	0 (-)	3 (14)	1 (4)
Zilkar Haor	37 (15)	11 (10)	18 (29)	12 (34)	3 (10)	7 (15)	8 (20)	7 (22)
KBK	23 (11)	9 (9)	7 (11)	5 (15)	2 (8)	2 (7)	4 (12)	8 (62)
All	94 (9)	38 (7)	40 (13)	27 (16)	12 (9)	21 (16)	28 (18)	27 (21)

Note: Figures in parentheses are percentage of earners who are not involved in the major source of imcome. Thus in all the projects together are 94 persons in the farmer households whose primary occupation is not farming and their proportion to the total number of earners in the farm households is 9%.

Source: PIE Survey

Table M. 8b Incidence of Secondary Occupations Among Earners.

Project	Farmer		Labourer		Fishermen		Others	
	Impacted	Control	Impacted	Control	Impacted	Control	Impacted	Control
Chalan Beel	76 (41)	47 (50)	16 (25)	4 (13)	3 (12)	11 (37)	20 (61)	12 (41)
Kurigram	80 (43)	18 (18)	21 (34)	2 (9)	3 (13)	6 (25)	9 (45)	9 (31)
MDIP	60 (34)	58 (58)	8 (12)	13 (39)	0 (-)	0 (-)	13 (59)	13 (52)
Zilkar Haor	50 (20)	25 (20)	13 (21)	4 (11)	3 (10)	0 (-)	25 (63)	16 (52)
KBK	59 (28)	32 (32)	14 (22)	5 (15)	16 (62)	19 (66)	6 (19)	13 (100)
All	325 (32)	180 (35)	72 (22)	29 (17)	25 (16)	36 (27)	73 (46)	63 (50)

Note: Figures in parentheses are percentage of earners who have a secoandary occupation. The same person may have more than one secondary occupatio.

Source : PIE Surveys

affected by changes in the viability of occupations (unlike fishermen and boatmen for example). However, a small tendency was found for the proportion of household heads primarily engaged in farming to increase since project completion (in both project and control areas, Table M.9). In MDIP and Zilkar Haor the increase is relatively larger in the project areas as a few households moved from other occupations such as salaries into primarily farming and this may have been because the projects have made farming more profitable. However, the overall occupational structures shown in Table M.1 largely reflect the sampling design and are not a measure of the incidence of income sources in the PIE areas as a whole.

Although the overall pattern of occupations may have remained the same, there might still be changes in occupations which have been self cancelling in aggregate. However there have been relatively few such changes (taking all earners in the sample households together), although detailed analysis of the data did reveal that 19 per cent of previous agricultural labourers in Kurigram South had moved into own cultivation since the project for example. In MDIP the main moves have been from salaried jobs into cultivation and from other occupations into trade; and in Zilkar Haor there has been a considerable two way movement between salaried jobs (often overseas) and cultivation. In the other two PIE projects there was no occupational mobility of note. Overall there has been consistently more occupational mobility in the project areas compared with the control areas, although the magnitude is not large (ratios of percentages of earners changing main income source since project, project:control - Chalan Beel 8:4, Kurigram 8:5, MDIP 8:3, Zilkar 12:10, and KBK 12:8; samples 1269 people in all project areas, 648 in all control areas). This is partly because in the project areas more households had members in education before the project who have started earning compared with the control areas over the same period. It may be that the projects have created more income earning opportunities, or that necessity has forced households in the projects to send to work members who might otherwise have stayed in education for longer.

Almost all the projects (perhaps with the exception of submersible embankments) showed disbenefits in terms of reduced employment for fishermen, and in several projects the RRAs reported that fishermen had moved into wage labour (Kurigram, Konapara, Halir Haor). In community surveys in the PIE projects it was reported that the number of boatmen had generally decreased in the projects compared with control areas, and hence boatmen have been adversely affected in several projects (for example, MDIP, Silimpur-Karatia, and in Zilkar Haor where boatmen also lost income from boulder collecting). Consequently boat-making carpenters also lost employment in these projects.

Improved year-round road communication in all the projects, except those with submersible embankments, appeared to have generated self-employment opportunities in road transport, marketing of agricultural inputs and outputs (Halir Haor, Katakhali Khal), and petty trades in goods and services. Improved road communication is partly attributed to internal road construction under FFW programmes, but in some cases was also part of the project investment (KBK). Improved communications have facilitated government and non-government development activities, which should have generated additional employment and income for poorer sections of the population, but it is difficult to discern any difference from unprotected areas.

While the RRAs provided qualitative evidence for these occupational changes, these changes do not show up clearly in the PIE surveys for the simple reason that the percentages of households involved in these changes are small and hence only small numbers of

Table M.9 Main Occupations of Household Heads

Category		Study area									
		Chalan Beel		Kurigram		Meghna-Dhonagoda		Zilkar Haor		Kolabashukhali	
		Protected	Control	Protected	Control	Protected	Control	Protected	Control	Protected	Control
Farmer	pre	70	76	72	70	68	71	67	76	70	73
	post	71	76	73	73	72	71	73	79	72	71
Ag lab	pre	27	23	26	28	28	29	22	20	25	27
	post	27	24	27	27	29	29	22	21	26	29
Fish	pre	0	0	0	0	0	0	1	0	0	0
	post	0	0	0	0	0	0	1	0	0	0
Trans	pre	1	0	1	0	0	0	0	0	1	0
	post	1	0	0	0	0	0	0	0	1	0
Trade	pre	0	0	0	0	1	0	1	0	0	0
	post	0	0	0	0	0	0	1	0	0	0
Salary	pre	0	0	0	0	3	0	6	1	1	0
	post	0	0	0	0	1	0	0	1	0	0
Non-farm labour	pre	1	0	0	0	1	0	2	1	2	0
	post	1	0	0	0	0	0	2	0	1	0
Non-earning	pre	1	0	1	0	0	0	1	1	2	0
	post	0	0	0	0	0	0	0	0	0	0

Source: PIE Surveys

households with occupational changes are found. Although a minority is involved this is nevertheless quite important since these occupations (trade and fishing in particular) have wider implications for many FCD/I project inhabitants.

M.3.3 Employment Changes

There are other more direct employment impacts of the projects. Project construction created short term employment for labourers, and modest minorities of the sample households had received employment, mostly as wage labour. Both farmers and non-cultivators had gained from this work both in the project benefited areas and in the adjacent impacted areas (this being one of the few benefits to people in these latter areas). There is little routine maintenance in any of the Projects evaluated; instead repair and rehabilitation of embankments creates periodic direct employment which helps to some extent labourers who might not otherwise benefit.

If the sources of employment are little changed the volume of employment might be expected to have risen with the growth in agricultural production. However, this is often more limited than might be expected since cropping intensities have often not increased substantially. Even so the evidence from a number of sources is that underemployment of household labour has declined and that there is more agricultural labouring available. For example in MDIP if the implications of the agricultural survey results are compiled then there are 131 days of labour per acre in the project area and only 105 days per acre in the control area. Moreover in MDIP a much higher proportion of this work is done by hired labour (60 percent) compared with the control area (about 30 percent). However, MDIP shows the greatest agricultural changes of the PIE projects; in others such as Chalan Beel Polder D and Kurigram there has been much less impact on employment, and similar proportions of labour are hired in project and control areas.

Table M.10 shows that the individual labourers interviewed did not report a consistently higher level of employment inside the projects; only in MDIP and KBK does the project appear to have benefited individual labourers by creating more work for them. Moreover competition for work means that wage rates are generally little different between project and control areas. Of much greater importance are the regional variations in wage rates which do not appear to be related to land productivity, but may be associated with population density (density is least in the Zilkar Haor area and highest in MDIP area).

In most projects the pattern of seasonal migration of labour is little changed. Very few labourers in the PIE surveys reported migrating out of their area to find work and in general the seasons of migration did not differ from pre-project times or from the respective control areas. However, some projects (such as Halir Haor) have clearly promoted in-migration at peak periods, but out-migration is not reduced at slack periods. In MDIP there has been some permanent in-migration attracted by employment and security from floods.

M.4 INCOME DISTRIBUTION

M.4.1 PIE Data

The impacts of FCD/I projects on income distributions are complex. The RRAs provided insights into the most obvious impacts, in particular identifying disadvantaged groups. The PIEs enabled some quantification of per capita income differences and the general

Table M.10 Agricultural Labour Employment and Wage Rates (1990-91)

Category	Study area									
	Chalan Beel		Kurigram		Meghna-Dhonagoda		Zilkar Haor		Kolabashukhali	
	Impacted	Control	Impacted	Control	Impacted	Control	Impacted	Control	Impacted	Control
Days work per annum	222	225	217	225	228	203	154	202	219	193
mean days per month	18.5	18.75	18.1	18.75	19.0	16.9	12.8	16.8	18.25	16.1
Peak month	Agrahan	Agrahan	Agrahan	Agrahan	Baishak	Baishak	Baishak	Agrahan	Agrahan	Agrahan
days	22	22	23	23	25	30	23	27	22	21
minimum month	Ashin	Ashin	Ashin	Ashin	Kartik	Ashin	Ashar	Ashar	Kartik	Baishak
days	12	13	9	9	10	7	6	6	15	10
Mean wage Tk/day	32.1	32.4	19.5	23.75	24.8	24.5	48.0	45.9	30.2	26.75
maximum wage	34	34	21	26	30	31	50	48	34	31
minimum wage	29	30	17	20	20	21	46	42	28	25

Source: PIE Surveys

differences between project impacted and control areas. Household incomes were calculated on the following basis. For agricultural incomes the actual crop yields reported by the household in the last cropping year (see Table M.11 for details) were multiplied by the relevant crop output price taken from regional statistics of mid-1991 prices (plus paddy straw and jute stick imputed values based on FPCO and MPO data), less the costs of production reported by the household. In Zilkar Haor (the first PIE), where a number of households gave very implausible input levels, average input levels after omitting these outliers were used. For livestock net income was assessed as the reported income from produce and sales of stock, less the costs of keeping animals reported by the household. Draught power services to the household were not imputed, and the income from hiring out draught power to other households may have been underestimated. For all other income sources the household was directly asked to estimate the cash and kind income over the last year. Hence the figures are unlikely to be very accurate, but should reflect the average incomes received by the household and in general there seems to be no reason to suppose that any category of households would systematically mis-report incomes more than any other category of household.

Table M.11 shows that in all the PIE projects, except for Chalan Beel Polder D, the project households averaged higher incomes than the control area households, although the difference is not large in KBK and Kurigram (8 per cent and 10 per cent respectively), while in Zilkar Haor it is enlarged over average year differences because the control area suffered flood damages to the main (Boro) crop in the year investigated. However, Table M.11 shows that the differences are not uniform across different landholding categories. Households have been categorised by the area of land owned, since this is an indicator of the wealth of the households. An area of up to 20 decimals (0.2 ac) was found to closely approximate to the landless or non-cultivating category, while the other categories accord with those commonly used in GoB statistics. Although mean farm sizes vary considerably between projects, with MDIP (particularly the control area) showing a relatively high proportion of smaller landholding households, the different study areas show broadly similar inequality in landholdings between project impacted and control areas.

While the largest landholding categories have substantially higher incomes in the impacted areas compared with controls (and this is averaged over all the impacted sample including any households which have been disadvantaged by the project - such as those in the adjacent impacted area), this is not always the case in the landless and smallest landholding categories. In Kurigram and MDIP these landholding categories do appear to be better off in the project impacted areas, but in Chalan Beel they appear to be worse off, while in Zilkar Haor and KBK the landless (labourers) appear to have benefited by higher incomes while the smallest cultivating landholding category have higher incomes in the control areas. A plausible explanation may be that FCD/I is only one factor affecting household incomes. The smaller landholding categories may have less diverse income sources than larger landowners, and so be more dependent on agriculture and face considerable residual environmental risks (despite FCD/I) and higher costs of production (with the increased use of HYVs and chemical fertiliser, and lower ownership of plough teams).

Since the original sample was stratified into cultivating and non-cultivating households, it is appropriate to assess the household income impacts of the projects for these two categories of household. Farming households should have benefited directly, whereas non-cultivating households would be affected indirectly by increased demand for labourers, increased opportunities for trade or decreased fish stocks for example. Table M.12 shows that farming households as a whole were much better off in the impacted areas in MDIP and Zilkar Haor than in their respective control areas. In Kurigram and KBK there is a small

Table M.11 Household Incomes (Tk per person in 1990-91) by Landholding Category in PIE Projects

Category	Study area									
	Chalan Beel		Kurigram		Meghna-Dhonagoda		Zilkar Haor		Kolabashukhali	
	Impacted	Control	Impacted	Control	Impacted	Control	Impacted	[1]Control	Impacted	Control
< 20 dec	2869	3391	1873	1507	2502	1939	1527	1298	2518	1877
21-100 dec	3155	4577	3443	1916	4157	2851	1946	2918	3138	3717
101-250 dec	4183	4135	4793	3672	5471	3726	4375	2015	3455	3245
251-500 dec	5018	5091	6020	5584	6454	6487	3865	3434	5368	5834
501-750 dec	6809	-	7507	5840	25601	11696	5422	770	5857	3176
+750 dec	11689	9282	10820	7128	15765	-	4841	1991	8220	5052
All households	4383	4360	4265	3850	4785	3246	3310	2175	3767	3486
Proportion of households in landholding categories										
< 20 dec	31	31	30	30	36	29	24	26	30	31
21-100 dec	24	27	25	11	27	46	22	18	22	20
101-250 dec	21	27	29	29	27	14	24	22	27	24
251-500 dec	12	13	11	17	7	8	16	24	15	13
501-750 dec	8	0	3	10	2	2	8	5	3	7
+750 dec	3	1	2	5	1	0	5	5	3	5
No households	168	84	168	84	168	84	166	80	168	84

Note: 1 Incomes in Zilkar Haor, particularly control area, were depressed due to flood damage of Boro in early 1990, so difference reflects effectiveness of project in an early flood year. Also unlike other projects agricultural year is rabi/boro 1989-90, aus and aman 1990 (others are: aus and aman 1990, rabi/boro 1990-91).

Source: PIE surveys

Table M.12 Incomes and their Sources for Cultivating Households in PIEs

Category	Study area									
	Chalan Beel		Kurigram		Meghna-Dhonagoda		Zilkar Haor		Kolabashukhali	
	Impacted	Control	Impacted	Control	Impacted	Control	Impacted	Control	Impacted	Control
Members/hh	6.4	5.7	6.2	7.0	6.7	6.4	8.8	7.4	6.4	6.4
Income										
Tk/hh	31117	34509	31137	32155	39114	24251	37786	23947	26696	25609
Tk/person	4888	6072	5042	4572	5831	3919	4298	3227	4166	3981
impacted income as % of control	**-19%**		**+10%**		**+49%**		**+33%**		**+5%**	
Percentage of Income from:										
cultivation	60	66	60	73	62	44	47	20	46	52
trees	9	8	8	9	5	6	5	9	10	10
homestead	2	1	1	1	1	1	1	2	3	2
livestock	5	4	3	1	3	3	5	9	4	8
salaries	4	1	10	5	16	9	30	38	18	10
business	1	0	2	0	2	1	4	3	2	0
rents	4	1	4	4	2	10	2	1	3	4
crafts	9	5	8	2	4	9	1	1	6	5
fishing	2	1	2	2	2	3	2	5	2	2
transport	0	1	0	0	1	0	0	1	0	0
wage labour	4	7	3	2	3	13	2	10	5	7
No households	120	60	120	60	120	60	120	57	121	59

Source: PIE Surveys

positive difference, while in Chalan Beel Polder D farmers appear worse off than their counterparts in the control area. The latter is not surprising given the frequent problems of cuts and breaches in the project and hence great uncertainty over agriculture - Chalan Beel Polder D is the one PIE project where there is no evidence of the project reducing the environmental variability facing farmers. The functional sources of these household incomes reveal, not surprisingly, a heavy dependence on cultivation. Only in Zilkar Haor control area was this a secondary source of income overall for farmers, and this is for the simple reason that flood damage resulted in negative or marginal returns to farming for many households in the year investigated, while a substantial proportion receive "salary incomes" particularly large remittances from household members working overseas. Salaries are also relatively important in KBK and MDIP - the former being relatively close to Khulna and the latter having a tradition of sending people away to find work.

One further feature of note in Table M.12 is that there is generally a higher proportion of income from labour in the control areas compared with the project areas. This could be because small farmers in the projects, having gained from increased returns to agriculture, have less need to supplement their incomes by labouring for others, or because all the gains go to the larger farmers and hence the same contribution from labouring (in absolute terms) becomes a smaller fraction of the higher overall income. However, there was only mixed evidence for smaller farmers gaining from the projects, so it may be that the projects have encouraged these households to improve their status by substituting paid labouring work for larger landowners with more work on their own land (as labour demand has increased per acre), even though this does not necessarily make the households financially better off.

Table M.13 reveals the very much lower per capita incomes of non-cultivating households, which throughout the PIE areas are predominantly dependent on wage labour. It also shows very little gain from the projects to these non-cultivating households, with the exception perhaps of KBK where the bringing of new land under cultivation (which does not show up in the farmer's incomes) may have increased demand for labour by a relatively large amount. The lack of a gain to non-cultivators in MDIP is notable since there has been a substantial increase in demand for labourers; however, this appears to have been filled by labourers from outside the project area.

M.4.2 RRA Insights

While the RRAs could not investigate distributional impacts and differences in general, they did reveal a number of factors and processes taking place in FCD/I projects which ultimately will have a bearing on income distributions, and this supplements the essentially static comparative data from the PIEs.

So far as direct income generation is concerned, there has been a lack of targeting of employment opportunities to the rural poor in FCD/I projects. The lack of routine maintenance means that, unlike the programmes of CARE and LGEB for rural roads inside the projects, little regular work has been directly generated for poor women or men. However, in some projects (BRE Kazipur, Halir Haor) poor people have found more or less regular employment in earthwork - in the former case because of erosion and retirements and in the latter case annual repairs of damage caused during submergence. Hence for landless labourers the direct long term income generation performance of the projects has been poor.

One of the conspicuous negative impacts of FCD/I projects has been a significant decline in the incomes of part-time and full-time fishermen and boatmen, but in none of the

Table M.13 Incomes and their Sources for Non-Cultivating Households in PIEs

Category	Study area									
	Chalan Beel		Kurigram		Meghna-Dhonagoda		Zilkar Haor		Kolabashukhali	
	Impacted	Control	Impacted	Control	Impacted	Control	Impacted	Control	Impacted	Control
Members/hh	4.8	3.9	4.8	5.5	5.9	5.9	6.2	6.2	5.1	4.9
Income										
Tk/hh	12770	11625	8257	8330	10681	10106	13615	15437	12914	9176
Tk/person impacted	2658	2968	1738	1526	1812	1708	2205	2483	2520	1866
income as % of control	**-10%**		**+14%**		**+6%**		**-13%**		**+35%**	
Percentage of Income from:										
cultivation	0	0	0	0	0	0	0	0	0	0
trees	7	5	10	11	7	8	7	13	8	9
homestead	1	2	3	3	2	1	6	6	2	2
livestock	2	1	2	1	3	2	2	2	4	5
salaries	4	4	4	7	12	1	2	0	1	0
business	0	0	0	0	0	0	0	0	0	0
rents	0	0	0	0	0	0	0	0	1	1
crafts	1	3	4	2	4	4	2	4	3	5
fishing	2	3	4	2	4	4	2	4	3	5
transport	0	0	3	1	0	6	3	1	6	0
wage labour	83	82	66	73	69	67	74	73	70	69
No households	44	24	48	24	48	24	46	23	48	24

Source: PIE Surveys

projects was there any institutional arrangement to compensate these people for such losses, even when the loss was anticipated during project appraisal (Chalan Beel, Polder 17/2). Traditional fishermen are not one of the higher income groups so this loss has had a negative distributional impact, over which there is widespread agreement among the project impacted populations (see Section M.8).

While it may be unclear whether FCD/I projects have any effect on river erosion, the impact of erosion as an agent of pauperisation of all categories of household is clear. The loss overnight of land, permanent homes, and trees drives many people from the active floodplain to seek shelter in adjacent projects, usually on the embankment (BRE, Kurigram). This may result in an apparent increase in inequality in projects since the disadvantaged seek shelter there.

Another source of unequal income distribution has been induced by BWDB through the construction of pucca irrigation inlets. For example, local influential people have been using these state-built structures directly (the weir in Kahua-Muhuri) or to operate LLPs (Chalan Beel Polder D) and then sell irrigation water to earn monopoly profits. Likewise in MDIP damage to the intended gravity distribution system has created an opportunity for entrepreneurs to supply irrigation water by LLP and so earn substantial profits. However, no instances of social conflicts were reported in this regard.

M.5 LANDHOLDINGS AND LAND ACQUISITION

M.5.1 Landholdings

Land is the major rural asset, and in the PIEs an indication of changes in landholding during the period since project completion (actually since approximately 1-2 years before project completion to allow for any changes due to land acquisition and land speculation) was obtained in both impacted and control areas. Hence, the periods of change are different for different projects. The method adopted was to record changes in holding due to project related land acquisition, sales and purchases of land; hence the changes in holding may not be complete since loss due to erosion, non-project acquisition, and deceit have not been included. Despite the relatively short periods of investigation (highest about 10 years in Kurigram), Table M.14 shows that in general 30-40 per cent of households have experienced changes in their landholdings (this includes both cultivating and non-cultivating households). However, changes in holding size do not appear to have been any more or less common in the impacted than in the control areas. Instead, the main differences appear to be regional: in Chalan Beel D and Kurigram similar numbers of households increased and decreased their holdings, whereas in the other three PIE areas much higher proportions of households (in impacted and control areas alike) lost land than gained land.

These changes may or may not be significant in terms of the agricultural viability and asset structure of the households, since changes as small as 1-2 decimals are included. Table M.14 also shows the changes in land distribution by categories since the projects: there is a lack of a common trend, although the proportion of effectively landless households (holdings up to 20 decimals) has increased while the proportion of medium landowners has tended to decline. The data on mobility between landholding categories charts 'significant' changes in landholding (changes between landholding strata). With the exception of Kurigram there has been rather more mobility in the project impacted areas than in the control areas. Hence, it would not appear that these FCD/I projects have prevented households falling into

Table M.14 **Landholding Distribution and the Incidence of Changes in Landholding Size in PIE projects since approximate date of Project Completion**

Category	Study area									
	Chalan Beel		Kurigram		Meghna-Dhonagoda		Zilkar Haor		Kolabashukhali	
	Impacted	Control	Impacted	Control	Impacted	Control	Impacted	Control	Impacted	Control
Percentage households experiencing change										
Increase	19	18	14	14	5	7	13	5	15	6
No Change	64	62	68	73	60	73	55	59	62	69
Decrease	17	19	18	13	36	20	32	36	23	25
Percentage of households in landholding category before project -> percentage in same category in 1991										
< 20 dec	30->31	32->31	29->30	29->30	33->36	30->29	14->16	15->19	27->30	32->31
21-100 dec	26->24	26->27	26->25	11->14	28->27	43->46	29->31	25->25	25->22	19->20
101-250 dec	20->21	27->27	29->29	25->29	29->27	17->14	28->24	24->22	26->27	20->24
251-500 dec	13->12	13->13	12->11	20->17	7->7	8->8	14->16	26->24	16->15	14->13
501-750 dec	9->8		3->3	7->10	4->2	2->2	10->8	5->5	4->3	10->7
+750 dec	2->3	1->1	2->2	5->5	1->1		5->5	5->5	2->3	5->5
Mobility between landholding categories (no households)										
Moved up	4	1	6	5	2	1	6	0	8	3
No change	160	83	152	73	150	81	141	73	146	74
Moved down	4	0	10	4	16	2	19	7	14	7
Total	168	84	168	82	168	84	166	80	168	84

Source: PIE surveys

lower landowning categories. However, in Zilkar Haor and KBK there has also been notably more upward mobility in landholdings than in the respective control areas - there have been agricultural benefits in these two projects, and particularly in KBK more land has been brought under cultivation. It may well be that changes in holding category have been more common in Projects where households took advantage of agricultural benefits and land price increases either to sell land for household needs (for example to offset flood damages, which still occur) or to invest elsewhere, or bought land to take advantage of more profitable agricultural opportunities. These impacts have been relatively less in Chalan Beel and Kurigram, hence the relative lack of landholding mobility in these projects.

The PIE studies suggest that the price of agricultural land has in general increased more in project than in control areas, except that irrigated and higher lands have similar price trends in project and control areas. Thus Table M.15 shows that non-irrigated land prices have invariably risen more inside the projects compared with control areas over the post-project period - on these land types the only difference since the project has been flood protection and drainage. It is also notable that the relative difference in price increase is greatest in Zilkar Haor and KBK - where the flood protection is relatively effective. In MDIP most land changed from non-irrigated to irrigated because of the project and hence the table is unable to detect the project's composite impact on land price.

The changes in irrigated land prices show no clear difference between project and control areas, since the changes largely reflect the introduction of irrigation which has been occurring independently of FCD in most of the Projects, and not the impacts of the projects themselves. However, the rate of increase in price for irrigated land has generally been higher than for non-irrigated land, and the incidence of irrigation (installation of private irrigation equipment) was found in most of the PIEs to have been higher in the project areas than in the control areas. Hence, relative land price movements have reflected changes in land productivity and hence agricultural benefits.

M.5.2 Land Acquisition

Although only affecting a minority of the impacted population, land acquisition for new and retired embankments, and drainage and irrigation channels, has been a major source of dissatisfaction with FCD/I projects. Table M.16 shows that only in MDIP and KBK did relatively high percentages of households lose land to the project. In the former case this is because relatively more land was needed for the gravity distribution irrigation system, but in the latter the reason is unclear except perhaps that households tend to own both higher land bordering the rivers (where the embankment was built) and lower land in the beels, and hence relatively more households would lose land than in the other projects which are topographically less uniform. The areas of land acquired per household are not inconsiderable given the small average size of holdings. Most of the land was cultivated, although a few homestead plots were acquired.

Given the importance of the land lost to the households concerned, it is clear that fair and speedy compensation is vital to those affected. Generally, prices paid for acquired land were not the source of discontent, although acquisition prices were less than the prevailing market prices. The extremely cumbersome process of land acquisition and long delays in making the actual payment (in some cases many years), and cases of partial or non-payment, have been the major sources of discontent amongst those whose land was acquired. Those who paid bribes did not appear to receive better prices or faster compensation. Table M.16 shows that in none of the PIE projects had compensation been paid without a bribe on more

Table M.15 Relative Land Price Changes in PIE Projects

Category	Study area									
	Chalan Beel		Kurigram		Meghna-Dhonagoda		Zilkar Haor		Kolabashukhali	
	Protected	Control	Protected	Control	Protected	Control	Protected	Control	Protected	Control
Irrigated land										
current price Tk/dec										
High	616	1280	721	300	1181	1200	1249	1000	500	480
Medium	839	655	711	500	1137	1000	1034	500	300	300
Low	548	620	591	350	1026	942	544	190	188	225
% change since project										
High	+104	+74	+79	+200	+100	+147	+9	+67	+67	+220
Medium	+74	+84	+97	+233	+146	+86	+17	+100	+140	+71
Low	+98	+87	+87	+133	+111	+100	+5	-28	+168	+50
Non-Irrigated land										
current price Tk/dec										
High	1018	986	600	400	1094	1102	1644	800	604	570
Medium	538	520	619	333	839	904	926	521	431	393
Low	648	525	475	125	847	818	660	279	320	358
% change since project										
High	+94	+74	+100	+74	+99	+71	+45	+2	+107	+50
Medium	+74	+68	+100	+90	+128	+72	+25	-1	+113	+46
Low	+82	+78	+85	+44	+106	+82	+60	-21	+116	+35

Source: community surveys in PIE projects

Table M.16 Land Acquisition in PIE Projects

Category	Chalan Beel	Kurigram	Meghna Dhonagoda	Zilkar Haor	Kolaba-shukhali
Percentage households losing land	9%	4%	29%	6%	20%
Mean area (dec) per affected household	18	46	44	54	35
Number of plots involved	18	11	58	14	43
Percentage of cases: compensated without paying bribe	44%	0%	24%	29%	40%
compensated after paying bribe	39%	36%	66%	42%	40%
not compensated	17%	45%	10%	29%	20%
not compensated despite paying bribe	0%	18%	0%	0%	0%

Source: PIE Surveys

than 50 per cent of acquired plots. Chalan Beel and KBK showed the best performances, in terms of bribes being less necessary, and most people being compensated. In MDIP the incidence of bribery to receive compensation appeared particularly high. In Kurigram the performance in land acquisition has been notably bad, and compensation has still not been paid on over 60 per cent of acquired land (in 18 per cent of plots even after bribes were paid). As a result in Kurigram farmers continue to be charged land taxes more than ten years after their land has been occupied by the embankment, creating further discontent. Payment of compensation and a transfer of title will be necessary if BWDB is to create use rights to the public infrastructure, or is even to have the right of access to the embankment which arguably still belongs to the landowners.

Discrimination about the fixing of compensation value between land categories, standing crops or groups of affected people was also a source of discontent in a number of major projects such as the BRE. BWDB and the administration need to expedite the process of compensation payment. This seems to be a prerequisite for involving the local people actively in managing the projects. In MDIP repeated embankment retirements during construction, and acquisition of land for these, created considerable resentment at the time, particularly as would-be beneficiaries found they were losing land to either the Project or river or both, although by the time of the PIE those affected had dispersed (the land having been eroded). At BRE Kazipur delays in paying compensation delayed the construction of the retired embankment, seriously affecting the quality of work.

M.6 INVESTMENT AND QUALITY OF LIFE

M.6.1 Non-land Assets

If FCD/I projects lead to increased agricultural output, this might result in investments in improved houses or tubewells, for example, and hence to a better quality of life. Although there has been an increase in the availability of tubewell water for drinking in the PIE projects this does not differ between project and control areas. Nor is there any evidence that in the PIE projects households invest more in education than they do in the control areas.

Table M.17 reveals that variations in housing construction types are primarily regional rather than project-control related. Thus earth houses (which are particularly vulnerable to flood damage) are very common in Chalan Beel project and control areas, and corrugated iron (CI) houses are commonest in MDIP (project and control area). Nevertheless there is some evidence of investments in improved housing in the three projects (MDIP, Zilkar Haor and KBK) where financial gains have been most apparent. In MDIP there are relatively more houses with CI components, whereas in the control area there are more all thatch houses. Also, more houses are in good condition; the lack of reported investments in housing since the project suggests this is not a project impact. However, this claim appears unreliable since it is known that flood damages in the Project area in 1988 would have resulted in many repairs and rebuilding (see Section M.7). Likewise in Zilkar Haor more houses are in good condition and the incidence of pucca and CI roofed houses is higher than in the control area, and there appear to have been more investments in housing since the project. In KBK the main house type difference was the use of earth in walls in the Project indicating greater flood security compared with the control area (although it is not clear if these are all earth houses or earth over straw construction); these would appear to be post-Project investments linked with the Project.

Table M.17 House Construction and Condition in PIE Projects

Category	Study area									
	Chalan Beel		Kurigram		Meghna-Dhonagoda		Zilkar Haor [1]		Kolabashukhali	
	Protected	Control	Protected	Control	Protected	Control	Protected	Control	Protected	Control
Type of wall (% households)										
pucca	2	2	5	6	0	0	20	6	6	0
CI	0	1	4	4	33	22	4	1	4	16
Earth	88	92	1	1	0	0	13	6	31	1
Thatch[1] wall CI/tile roof	2	1	33	33	57	49	42	34	33	37
Thatch wall and roof	5	4	58	56	10	29	22	53	26	46
Condition of main house (% households)										
Good	18	17	16	25	24	10	23	5	13	12
Fair	49	57	44	27	46	51	50	49	43	38
Poor	33	26	41	48	30	40	27	46	44	50
If invested in house since project completion (% households)										
new room	12	13	15	21	9	6	19	6	19	7
major repair	36	25	53	46	41	43	32	25	35	46
both above	0	0	1	0	0	0	1	4	2	0
not invest	52	62	31	32	50	51	48	65	44	46

Source: PIE Surveys

The sample households own various other non-land assets. Among these the ownership of livestock is discussed in Appendix I. Here the ownership of a few selected items (plough, fishing net, boat, bicycle and hand-tubewell) is analysed (Table M.18).

One would expect most farmers to own a plough, but apart from Zilkar Haor, in all other areas substantial numbers of marginal-smaller farmers are without a plough, particularly in MDIP with only 40 per cent owning ploughs. The 'other' households include a number with ploughs (a fairly substantial number of earners from such households are also farmers). There appears to be no definite pattern in the incidence of plough ownership between impacted and control areas.

Most fishermen's households own at least one net, but many do not own a boat. While labouring households own few boats, the pattern of ownership among farming households is closely attuned to the monsoon/flood conditions: the incidence of boat ownership is generally lower in the impacted areas, except in Chalan Beel where the control area is not very floodprone (Section M.7). It is only in Kolabashukhali that there is little difference between impacted and control areas and the highest incidence of boat ownership, and here the project has left very large areas of beels (although the depths are reduced) for which farmers need boats if they are to tend and harvest their paddy.

The incidence of ownership of fishing nets among non-fishermen households yields some interesting patterns. In two projects (Zilkar Haor and MDIP) the incidence is far lower in the impacted areas than in the control areas, and this may reflect a project impact on floodplain fisheries. In Kolabashukhali and Kurigram, where riverine fishing is important, there is little difference between impacted and control areas. In Chalan Beel where open capture fisheries have been substantially lost (Appendix J), there is higher ownership of nets in the impacted area; but in Chalan Beel Polder D pond fisheries have begun to be developed by farm households. The Chalan Beel figure for net ownership is the lowest among all the project-impacted areas, and the control area may also be lacking major fisheries.

M.6.2 Credit

Access to credit might constrain the ability of households to take advantage of the opportunities created by FCD/I projects. While FCD/I projects should have reduced risk and hence the taking of loans to meet post-flood needs, the projects should also increase the returns to productive investments such as in agriculture which would (at least initially) need credit for their finance. Table M.19 shows that among cultivating households the incidence of credit taking is only higher in the project area in Zilkar Haor, although the average loan per household is also higher in the projects in Chalan Beel D and MDIP. Strangely, inside Chalan Beel D there is a notably high use of credit for investment in farming, despite the uncertainties created by public cuts. However, private irrigation is widespread in this area and the credit seems likely to be for Boro cultivation which is unrelated to the Project and not subject to flood risks. In the other PIE projects very little of farmers' credit is used for investment, most being used for immediate necessities.

The pattern among non-cultivators is unclear (Table M.19). Relatively high numbers of households had taken loans in the year prior to interview, and in MDIP and Zilkar Haor many more households in the protected area had taken loans than in the control area, yet in virtually all cases the loans were used for basic necessities or social needs and very rarely for anything which could be termed an investment (e.g. house repair). This is perhaps consistent with these two projects failing to create real financial gains for non-cultivating

Table M.18 **Incidence of Ownership of Selected Non-land Assets and Tools (% of households owing).**

Type	Farmer		Labourer		Fishermen		Others	
	Imp.	Cont.	Imp.	Cont.	Imp.	Cont.	Imp.	Cont.
CHALAN BEEL POLDER-D								
Plough	67	55	-	-	-	-	21	28
Fish Net	35	22	7	8	93	-	29	94
Boat	11	2	-	-	71	-	21	50
Bicycle	38	32	-	-	-	-	36	78
HTW/MOSTI	17	13	-	-	-	-	14	11
KURIGRAM								
Plough	69	87	-	-	7	-	36	33
Fish Net	46	43	25	17	87	93	21	13
Boat	-	3	-	-	27	20	7	-
Bicycle	48	45	2	-	20	20	36	53
HTW/MOSTI	43	27	-	-	-	-	29	53
MEGHNA-DHONAGODA								
Plough	38	42	-	-	-	-	7	11
Fish Net	40	62	23	42	93	80	7	27
Boat	14	22	2	13	80	-	28	17
Bicycle	4	2	-	-	-	-	-	-
HTW/MOSTI	26	12	-	-	-	-	14	17
ZILKAR								
Plough	86	93	-	-	-	-	7	20
Fish Net	47	70	12	57	94	87	35	47
Boat	19	28	5	9	13	67	20	27
Bicycle	4	4	-	-	-	-	15	13
HTW/MOSTI	6	7	-	-	-	-	10	13
KOLABASHUKHALI								
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

Note: Figures im parenthesis are percentage of earners who have a secoandary occupation. The same person may have more than one secondary occupatio.

Source : PIE Surveys

Table M.19 Access to Credit and Use of Credit during 1990-91

Category	Study area									
	Chalan Beel		Kurigram		Meghna-Dhonagoda		Zilkar Haor[1]		Kolabashukhali	
	Protected	Control	Protected	Control	Protected	Control	Protected	Control	Protected	Control
Cultivators										
No households	120	60	120	60	121	59	120	57	120	60
% households taking loan	35%	38%	42%	48%	50%	46%	58%	26%	43%	38%
Mean loan over all households	3727	2063	2472	3661	2767	1516	4581	2544	2395	2942
Percentage use for:										
cultivation	36%	26%	15%	30%	11%	4%	10%	7%	12%	5%
livestock	8%	4%	2%	0%	3%	0%	6%	1%	0%	0%
house repair	5%	4%	0%	0%	1%	3%	2%	6%	0%	0%
necessities	48%	52%	76%	67%	81%	84%	72%	79%	86%	90%
social duties	3%	13%	7%	3%	4%	8%	10%	7%	0%	5%
Non-Cultivators										
No households	46	24	48	24	48	24	46	23	48	24
% households taking loan	13%	33%	54%	62%	83%	38%	65%	13%	60%	54%
Mean loan over all households	198	350	1198	806	1516	885	1735	304	1139	1050
Percentage use for:										
cultivation	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
livestock	0%	4%	0%	0%	0%	0%	0%	0%	0%	0%
house repair	0%	13%	8%	0%	7%	0%	3%	10%	0%	0%
necessities	100%	70%	88%	93%	91%	100%	97%	71%	100%	100%
social duties	0%	13%	4%	7%	3%	0%	0%	19%	0%	0%

Source: PIE Surveys

households, although it might have been hoped that FCD/I at least created greater stability in earnings than in the control areas.

M.7 FLOOD IMPACTS

M.7.1 Incidence of floods

Apart from direct impacts on agriculture the main means by which FCD/I projects could directly affect socio-economic welfare is by protecting people from flooding: from losses to their own property, from disruption of their income flows, and from disruption to the local economy on which they are dependent. With the exception of submersible embankments, FCD/I projects are intended to provide protection from flooding to property and infrastructure. This has happened in some projects (such as Polder 17/2), but in many there appears to develop a false sense of security. Table M.20 shows that the PIE Project areas were subject to frequent flooding, often every year, before the Projects, but that flooding has occurred inside most of the Projects since their completion (either through embankment failures, cuts or greater than design standard events). The incidence of damaging floods (averaged over a 10 year period to standardise for the different periods since completion) does not appear to be very different in recent years between project and control areas (Table M.20).

Table M.21 shows that very few households in the PIE surveys had been flooded since 1988, with the exception of Zilkar Haor where a small number of households appear to suffer each year (note that the number of households differs between years since those flooded in 1991, for example, were not asked to give details of earlier floods, so they may also have been affected in 1988). However, a high proportion of households suffered flooding of the homestead area in 1988, whether in protected or control areas. The exception is Chalan Beel area where the control area suffered very little household flooding (it is less floodprone than the project area), and even the Project area suffered a low incidence of homestead flooding. Given the high incidence of flooding reported there in general, it would appear that agricultural flooding is common but that homesteads are well adjusted to the range of floods experienced.

M.7.2 Flood damages in 1988 and 1987

In the most recent extreme floods in 1988 (Table M.21) the PIE Projects failed to show any general reduction in the incidence of property damage between project and control areas (only in KBK does it appear that a smaller proportion of households suffered non-crop damages). Of even greater concern is the apparent worsening of flood impacts among those households affected in the Projects compared with control areas. Flood depths in the homestead were on average deeper inside the Projects (notably so in MDIP) although flood durations were only longer inside three of the five Projects. Also average damages to property among the affected households were higher inside three projects than in the control areas, and in the other two Projects property damages did not differ significantly between project and control areas. There is also a tendency towards higher flood damages to rural businesses inside the project areas (see Appendix K).

Table M.20 Percentages of Mouzas Reporting Floods pre- and post-Project

Category	Chalan Beel	Kurigram	Meghna Dhonagoda	Zilkar Haor	Kolaba-shukhali
Pre-Project					
Protected					
every year	77	62	95	67	58
some years	18	29	5	22	37
rare	5	9	0	11	5
Unprotected					
every year	0	67		25	
some years	0	0		50	
rare	100	33		25	
Control					
every year	50	-	50	33	33
some years	0	-	50	17	67
rare	50	-	0	50	0
Post-Project					
Protected					
flooded	95	91	100	100	74
no flood	5	9	0	0	26
mean no floods in 10 years	3.1	2.4	3.6	5.5	1.2
Unprotected					
flooded	100	100		100	
no flood	0	0		0	
mean no floods in 10 years	5.3	4.0		6.4	
Control					
flooded	67	-	100	100	100
no flood	33	-	0	0	0
mean no floods in 10 years	2.7	-	3.5	4.2	-
No villages					
protected	22	21	20	10	19
unprotected	2	3	0	4	0
control	4	0	8	3	3

Source: community surveys, PIEs

Table M.21 Recent Damaging Floods and Non-Crop Household Losses in PIE Study Areas

Category	Study area									
	Chalan Beel		Kurigram		Meghna-Dhonagoda		Zilkar Haor		Kolabashukhali	
	Protected	Control	Protected	Control	Protected	Control	Protected	Control	Protected	Control
Percentage households affected in[1]:										
1991	0	0	4	6	0	0	9	6	1	0
1990	1	0	3	5	0	0	8	9	2	0
1989	1	1	0	1	0	0	9	3	4	2
1988	28	8	50	27	97	88	71	80	46	73
1987	4	1	0	0	?	?	0	0	0	9
1988										
Mean depth (ft) in homestead	1.7	1.6	1.8	1.6	3.0	2.3	2.3	1.6	2.1	1.7
mean duration days	8	16	9	6	21	18	7	8	21	14
Mean damage per affected household (Tk)	1979	1486	771	777	1433	813	4191	1128	1229	1314
% affected suffering financial loss	76%	71%	82%	80%	96%	99%	81%	75%	70%	70%

Note 1 since households were only asked to give details of the most recent flood affecting the homestead area, the available number of households declines for earlier years, in the case of MDIP so few households were not flooded in 1988 that an estimate of the incidence of flooding in 1987 would be unreliable from this source.

Source: PIE Surveys

Taking the household losses as a whole (loss per household) by combining the damages per affected household and the percentage of affected households, reveals very much higher damages in 1988 inside four of the projects compared with their control areas. The one exception is KBK where the loss per household was 70 per cent less than in the control area. This confirms the impression from the RRA of this project that damages and flood impacts were less and of the project's relative success in 1988. In the other four projects the damages per household in the Project area range from 184 per cent (Kurigram) to 466 per cent (Chalan Beel D) higher than in the respective control area. This trend probably reflects a combination of the following factors: increased wealth in some projects (for example in Zilkar Haor houses are of better quality and so for a given depth damages will be higher than in the control area); settlement on lands which would have been regarded as too risky had there been no project; the decline of previous household adjustments to flood risk; more rapid flooding due to public cuts and embankment failures than happened in the control areas; and ponding up of flood water inside the projects (whereas control areas have freer drainage after an exceptional flood). Hence it does **not** appear that FCD/I Projects are successful in extreme floods in reducing non-crop flood damages, and they may well worsen losses.

Crop damage (Table M.22) was reportedly less in 1987 and 1988 in three of the PIE Projects compared with the control areas (Kurigram, Zilkar Haor and KBK). Kurigram South appeared to be notably successful in having low flood damages in these two years, but it should be noted that there is relatively more high land in the Project than in the control area and so damages in this control area may not be a good indication of what would have happened without the Project. However, crop damages were more in Chalan Beel and MDIP than in their control areas, although the magnitude of losses reported may not be so reliable after recall over several years (for example, in MDIP in 1988 Aus crops were good just prior to harvest at the end of July, and the embankment breached on 1st September, yet a very low yield was claimed in the PIEs). Both these Projects suffered breaches (and cuts in Chalan Beel) in both these years - in such cases the Project areas appear to be worse off than the Control areas due to the rapid inflow of flood water, and this risk and its implications ought to be taken account of in assessing potential project benefits.

Where FCD/I projects have undoubtedly provided benefits in high floods is in providing embankments which act as flood shelters or refuges. This was found in the RRAs in about half the Projects studied, and in these cases distress and losses have been less than they might otherwise have been (at least for those who were not flooded more severely because of the project). In projects, such as BRE and Kurigram, that have experienced unprecedented river erosion and abrupt landlessness, embankment sections have been used for permanent or semi-permanent linear housing by those who have lost land due to river erosion. In a land scarce situation this can be treated as an unintended but low-cost rehabilitation of dispossessed people, but in its current form this undermines the quality of the embankments. In some cases such as BRE, the embankment should be designed for this use as there is no alternative resettlement area. However, the embankments are often themselves threatened by erosion (BRE, Kurigram, MDIP) and so the sense of security is even less justified.

In all projects there is an urgent need to prepare flood disaster contingency plans for the project inhabitants and the embankment settlers, and to provide an effective system of advance warning of floods and the risk of embankment failure, and safe refuges for project inhabitants.

Table M.22 Flood Impacts on Crops in 1987 and 1988 in PIEs (percentage of normal yield achieved)

Category	Study area									
	Chalan Beel		Kurigram		Meghna-Dhonagoda		Zilkar Haor [1]		Kolabashukhali	
	Protected	Control	Protected	Control	Protected	Control	Protected	Control	Protected	Control
1987										
B Aus	27	56	59	18	15	65	59	52	28	29
HYV Aus	62	68	51	0	26	50	58	17	81	-
Jute	25	65	53	14	26	73			20	21
B Aman	22	51	73	0	20	50	58	38	36	19
LT Aman	25	51	62	20	8	38	79	68	48	15
HYV Aman	30	58	58	11	8	70	48	13	31	58
1988										
B Aus	39	50	56	33	12	40	11	17	20	29
HYV Aus	91	52	52	0	22	25	14	5	74	-
Jute	30	59	49	14	22	55			24	32
B Aman	35	48	76	0	15	33	10	9	24	13
LT Aman	40	47	70	20	3	32	18	22	44	15
HYV Aman	35	45	60	8	7	20	9	0	28	41

Note 1 In Zilkar Haor only part of the project protects these crops, the main benefit is from protecting Boro from eary flood damage which was not investigated in the mouza surveys.

Source: Mouza surveys of PIE projects

M.7.3 Depth-damage data for household (non-crop) flood losses

The PIE surveys provided an opportunity to compile some data on non-crop flood losses. Most of the data referred to 1988 - although this relies on recall over three years it has the advantage of being removed from the immediate time when hopes of relief might be expected to inflate figures. Since flood damages relate to the type of house affected and the parameters of flooding (depth, duration, velocity etc.) rather than to Project or Control area characteristics per se, data from all the study areas have been amalgamated. It should also be remembered that although much of the data used derive from "protected" areas rather than unprotected areas, flooding may have been more sudden there and hence damages higher than they would be in without Project conditions. However, in the interests of simplicity all floods have been treated alike, and data averaged over these varied conditions are presented.

Table M.23 reports the survey based data. Since these are empirical flood loss data rather than generalised damage data, they show some inconsistencies and the influence of small samples in some house type/depth combinations. Losses are categorised on the basis of main wall construction material of the main house, since the risk of house collapse and cost of repairing the walls of the main house is a major component of losses. Roof damage, while included in costs of repair, was not taken to be a primary factor in determining damages, since damage may be due to heavy rainfall rather than flooding (and hence not be preventable by flood protection). Although data from years other than 1988 were obtained, the samples are relatively small in other years, so for simplicity only damages in 1988 have been included. Also the figures do not include damages to business premises or their stock - only three shops were reported damaged in the PIE surveys. Hence the figures are for private homesteads only and ignore damages to businesses or infrastructure.

In Table M.24 damages in adjacent depth categories have been averaged to exclude a few outliers which may have over or understated damages or be atypical, and to avoid the implausible result of damages falling with flood depth. However, the figures are still entirely empirical and based on actual reported flood damage rather than potential damages. Hence the data depend on the range of house sizes and construction types found in the survey households, the extent of warning and damage mitigation actions taken by the households, and the characteristics of the floods experienced; they do not represent an average property of a given type and size flooded to different depths.

Nevertheless the results appear plausible: at one foot of flooding earth houses show the highest losses since they are at high risk of collapsing, while damages to pucca housing increase rapidly with depth (in the range with data available) presumably due to the high cost of the materials involved. Thatched and CI construction houses have damages increasing steadily with depth of water and which do not differ greatly between each other. Table M.24 also reveals that the great majority of damages are to the house structure itself, except for pucca houses with one foot of flooding (where there is no risk of collapse). Damages to stored food and to other assets and possessions were very much less, suggesting that people were able to move property above flood levels or to salvage it (unless an item had to be replaced or major repairs undertaken, households will generally not have reported any damage).

Table M.23 Non-crop Flood Damages by Property Type and Depth of Flooding in 1988 (1988 prices)

Depth (ft)	Construction type (walls) Pucca Mean	N cases	CI Mean	N cases	Earth Mean	N Cases	Thatch (straw etc) Mean	N Cases	Wood Mean	N Cases
0	-	0	-	0	-	0	0	1	-	
1	533	12	727	11	1924	32	764	140	0	1
2	3922	9	1962	30	2196	23	1095	172	1100	4
3	3000	1	1599	26	3230	10	1485	124	1350	1
4	50000	2	1937	15			1895	45		
5							1573	11		

Note: depths are ft of water above floor level

Source: all PIEs

Table M.24 Modified depth-damage data for main rural property types, 1988 damage figures

Type and depth	Tk/ property	% damage contributed by building	food stock	contents/ other assets
Pucca wall				
0	0			
1	533	30	0	70
2	3830	78	15	7
3	3830	78	15	7
Corrugated Iron wall (and roof)				
0	0			
1	727	75	5	20
2	1793	71	7	22
3	1793	71	7	22
4	1937	79	2	19
Earth wall (all roof types)				
0	?			
1	1924	87	2	11
2	2197	80	19	1
3	3230	90	3	7
Thatch wall (grass, bamboo, jute sticks; roof usually also thatch)				
0	0			
1	764	92	4	4
2	1095	85	8	7
3	1485	85	6	9
4	1832	82	15	3
5	1832	82	15	3
Wooden wall (CI roof)				
0	0			
1	0			
2	1100	91	0	9
3	1350	81	0	19

Note: Damages have been averaged over depths where the survey data would imply a decline in damages with depth (the latter is not plausible and arises because the data reflect actual floods and different depths in different houses rather than different depths in the same houses). Damages include all non-crop non-buisiness losses to the household, and not just damages to the main house (although the latter is the main component).

Source: all PIEs

While these data are incomplete and could be improved on, they may be of use to other components of FAP in estimating potential property losses, provided estimates of the depths of flooding in homesteads can be predicted. However, it will be important in using these data not to assume blindly that FCD projects will prevent floods when it is clear that in practice despite, or even because of, the projects damages can be high in floods of moderate to extreme return periods.

M.8 LOCAL PARTICIPATION, OPINIONS AND SOCIAL CONFLICT

In general, local people were not consulted at any stage of project planning or construction. Local committees for the implementation phase of the Projects were rare - 10-30 per cent of the surveyed villages reported the presence of such a committee in their village. As a result local knowledge about the physical and social features of the project area could not be utilized. In a high proportion of villages (in both protected and unprotected impacted areas) the community reported that there were doubts about the necessity of the Project at the time of implementation (Table M.25), but this generally led only to dissatisfaction, although a number of feuds did occur. Similarly in all the PIEs about 25-35 per cent of the impacted respondents reported having doubts about the usefulness of the project during the construction phase (when they first became aware of it), but relatively few took action to prevent construction.

People's participation in the regular O&M of the projects was in general absent, or limited to pre-Project water management practices which persisted despite the Project (KBK, Halir Haor). In some projects, where people perceive the positive benefits of the embankment, the local people have voluntarily mobilized themselves and raised money and materials in order to protect or repair the embankment during high floods (Kahua Muhuri) or when breaches and public cuts are threatened (Chalan Beel, Katakhali Khal).

Despite a definite increase in agricultural production and consequent increase in employment in the crop and non-farm sectors in most of the studied projects, the FCD/I projects have been responsible for increasing conflicts of interest. The major forms of conflicts found in the RRAs are:

- discontent between those living inside the project and those left outside the project, because the latter face more inundation and water congestion than in the pre-project situation, leading to public cuts or threat of public cuts in the embankment (Chalan Beel, Silimpur-Karatia, Kurigram, Konapara - in the last case the conflicts over public cuts were so severe as to lead to deaths);

- conflicts of interest between farmers and fishermen concerning the timing of sluice gate operation or building of cross bunds were frequent (Zilkar Haor, Halir Haor, Chalan Beel, Nagor River, Sonamukhi-Banmander);

- conflicts between boatmen and farmers arose in Zilkar Haor and Silimpur-Karatia because structures obstructed navigation routes;

Table M.25 Extent to which Villages Doubted the Necessity of Projects and Actions Taken

Category	Study area									
	Chalan Beel		Kurigram		Meghna-Dhonagoda		Zilkar Haor		Kolabashukhali	
	Protected	Unprot	Protected	Unprot	Protected	Unprot	Protected	Unprot	Protected	Unprot
No villages	22	2	21	3	20	0	10	4	19	0
Percentage reporting doubts over project at time of implementation										
No doubts	55	50	47	33	35	-	50	0	11	-
Don't Know	4	0	24	0	0	-	10	75	16	-
Doubted Project	41	50	29	67	65	-	40	25	26	-
No villages doubting project desirability										
	9	1	6	2	13	-	4	4	5	-
Percentage of these experiencing feuds	11	100	17	100	15	-	50	0	0	-
dissatisfied	89	0	83	0	85	-	50	100[1]	100	-

Note: 1 in Zilkar Haor unprotected area only one of the four villages with doubts reported what happened.

Source: mouza surveys, PIE projects

- conflicts among cultivators may arise between farmers on low and high land (several projects), and where local influentials take a profit by leasing out khas land to the landless (Halir Haor) or by monopolising it for their own benefit (KBK); and

- in Polder 17/2, conflicts of interest between farmers and shrimp farmers arise since shrimp farmers introduce saline water into the polders without paying the small landowners fair rents or compensation for the use of their land. A related problem arises in KBK, where shrimp farmers open sluices for fry collection without regard to the damage caused to crops by saline water.

In several projects the resolution of such conflicts necessitates local and official intervention and thus raised the demand for scarce administrative and political resources.

In the PIEs household heads were asked for their opinions concerning project impacts and these confirm many of the broad findings and the importance of the above issues. Table M.26 shows that most protected households regarded flood protection of crops and homesteads to be major benefits of the Projects, although it is notable that fewer households reported homestead protection to be a benefit compared with crop protection. The growing of extra crops also appears to be an important perceived benefit although higher cropping intensity compared with control areas was negligible or modest in most of the the PIE projects (Appendix H). The other major benefit perceived has been improved communications which have also benefited unprotected areas, and even appear to be important in MDIP where an important negative impact on boat transport has been noted.

Relatively few households reported no problem or disbenefit created by the Projects (Table M.27). The main negative impacts have been waterlogging (including of adjacent unprotected areas) and the decline of capture fisheries - although this was regarded as much less of a problem in Zilkar Haor (submersible embankment) than in the other projects. Damage to the embankment itself is clearly perceived as being a major problem in the three projects experiencing major breaches, and in Chalan Beel people are also well aware of the threat and problems created by public cuts (to insiders and outsiders). Although loss of soil fertility and silt deposition is often regarded as an adverse impact of FCD/I projects it only appeared to be perceived as a major problem in KBK where also some households noted a decline in soil moisture. A decline in boat transport was noted as relatively important in MDIP and Chalan Beel. However, it is of interest that relatively high percentages of households in MDIP and Zilkar Haor reported increased pollution of waterbodies because of the projects and this would merit further investigation (see Appendix N).

The distributional impacts of the Projects have already been discussed on the basis of incomes reported by households in the PIEs, but household heads were also asked to identify which groups they believed had benefited and disbenefited most. The results (Table M.28) show, interestingly, very good agreement with the calculated differences between the sample households (suggesting that Project-Control differences are indeed a measure of project impact). While farmers in general are seen to have benefited it is clear that larger landowners are the most benefited group, whereas very few people believe that marginal landowners have benefited (or disbenefited).

Table M.26 Percentage of Surveyed Households Reporting Different Benefits in PIE Projects

Category	Study area									
	Chalan Beel		Kurigram		Meghna-Dhonagoda		Zilkar Haor		Kolabashukhali	
	Protected	Unprot	Protected	Unprot	Protected	Unprot	Protected	Unprot	Protected	Unprot
Extra crop	27	7	26	0	54	na	14	4	26	na
Increased irrigation	3	0	3	0	7	na	4	1	1	na
Grow HYVs	7	0	4	0	23	na	9	0	1	na
Crops saved from flood	50	21	71	9	68	na	55	19	86	na
Livestock protected	1	7	7	0	1	na	7	1	2	na
Homestead protected	27	21	40	0	30	na	25	3	44	na
Better communications	69	57	65	29	69	na	40	26	79	na
Fish cultivation	6	0	2	0	0	na	2	0	1	na
Rural industry increased	0	0	0	0	3	na	0	0	0	na
More work	0	0	1	24	11	na	0	1	0	na
None	15	36	10	43	0	na	23	63	0	na
No Households	154	14	147	21	168	0	96	70	167	0

Note: respondents were asked to identify up to three main benefits of projects so percentages do not sum to 100.

Source: PIE Surveys

Table M.27 Main Disbenefits and Problems of PIE Projects (percentage households reporting problem)

Category	Study area									
	Chalan Beel		Kurigram		Meghna-Dhonagoda		Zilkar Haor [1]		Kolabashukhali	
	Protected	Unprot	Protected	Unprot	Protected	Unprot	Protected	Unprot	Protected	Unprot
Damage to embankment	47	43	40	9	44	na	1	0	17	na
Public cuts	51	29	10	29	3	na	1	4	6	na
Waterlogging	56	57	28	9	51	na	72	62	60	na
Decline soil fertility	11	7	26	4	21	na	2	17	46	na
Decline soil moisture	6	0	3	0	10	na	1	1	15	na
Less silt deposition	10	0	22	0	18	na	6	1	29	na
Land erosion	1	0	2	33	1	na	0	3	0	na
Land acquisition	1	0	1	4	1	na	1	0	2	na
Damage to house	0	0	0	29	1	na	0	1	0	na
Loss of fish (capture)	35	71	37	4	71	na	18	19	40	na
Decline in boat transport	18	29	6	9	35	na	9	11	13	na
Pollution of waterbodies	5	0	2	0	30	na	44	38	8	na
No problems	5	0	25	19	6	na	?	?	9	na
No Households	154	14	147	21	168	0	96	70	168	0

Note: respondents were asked to indicate the three main disbenefits and the three main problems with their project, results have been amalgamated by taking the higher percentage reporting a problem where both answers were available in the two questions, except in Zilkar Haor where for most problems respondents were asked to indicate if it was a problem.

Source: PIE Surveys

Table M.28 Percentages of Respondents Believing that Different Interest Groups Benefited or Disbenefited from the Project

Category	Study area									
	Chalan Beel		Kurigram		Meghna-Dhonagoda		Zilkar Haor [1]		Kolabashukhali	
	benefit	disben	benefit	disben	benefit	disben	benefit	disben	benefit	disben
Large landowners	59	17	70	4	90	1	60	13	84	2
Marginal landowners	3	4	2	2	5	1	3	11	4	0
Mainly labourers	37	18	51	3	75	1	22	8	71	1
Mainly farmers	30	14	41	3	57	2	33	21	38	2
Mainly fishermen	4	34	1	30	1	65	1	38	1	49
Mainly buisinessmen	22	0	14	0	11	5	10	2	23	4
Mainly boatmen	1	28	2	8	1	47	2	22	0	34
People outside project	2	27	1	39	0	39	2	26	0	54
No Households	161	162	165	158	168	168	124	134	164	143

Source: PIE Surveys

Surprisingly, there is wide agreement that labourers have benefited except in Zilkar Haor and Chalan Beel D (the two projects where the non-cultivators appear worse off than in control areas). Businessmen were regarded as having generally benefited but to a lesser extent. Equally there was common agreement on the groups who were disadvantaged: fishermen in particular, but also boatmen and people living outside the Projects. The latter disbenefit was even noted in those projects where the sample did not include people from the impacted unprotected area (MDIP, KBK); hence adverse offsite impacts appear to be widely perceived, even by those living inside the projects.

Given that there is widespread agreement on the impacts of FCD/I projects among those affected, and that these perceptions and beliefs appears well founded as shown by the PIE surveys, there is a common basis on which compromises in project planning and management could be found with the aim of compensating for and minimising disbenefits.

APPENDIX N

ENVIRONMENTAL EVALUATIONS

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APPENDIX N

ENVIRONMENTAL EVALUATIONS

N1 INTRODUCTION

This Appendix summarises the main features of the FAP 12 environmental evaluation methodology (described in detail in the FAP 12 Methodology Report) as applied to the five PIE study projects, and sets out the findings of the Preliminary Environmental Post-evaluations (PEP) of those projects. Readers requiring details of the environmental scoping and screening exercises for each project which led to those findings are referred to the relevant individual PIE reports. The findings of the less detailed screening and scoping undertaken for the RRA studies have been summarised in Section 3.11 of Volume 1 of the present report, and are not presented here. Readers requiring details of the environmental evaluations conducted as part of the RRAs are referred to the individual RRA reports.

N2 APPROACH AND SOURCES OF INFORMATION

N2.1 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 field observations and interviews are more intensive along carefully selected transects. The selection of transects is important because the PEP attempts to evaluate environmental impacts in terms of the different agroecological divisions, so that the transects must cross a representative selection of these, enabling contrasts and interrelationships to become apparent.

The PEP adopts different time and spatial perspectives to those of the PIE socio-economic surveys. The latter compare the Project Area with a purposively selected Control Area 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 affected by the Project. The PEP also evaluates the environmental impacts of the Project over all the years since project completion (and where necessary any impacts during construction that are of long-term significance).

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

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

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

Within the projects selected for PIE study, the spatial framework of the PEPs is provided by the Agroecological Divisions (AED) composing each project area. The AEDs are based on a refinement of the agroecological classification given in FAO (1988), and comprise broadly homogeneous physiographic and soil units. The environmentally impacted areas external to the projects are assessed as separate units.

N2.2 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. Three trends of outstanding importance are the continuing growth in population pressure, the depletion of capture fishery resources and the spread of tubewell irrigation. The two latter may be partly related to FCD/I projects impacts, but the first (and most important) is not. It is necessary to assess also the impact of what the projects have achieved in practice, rather than the anticipated impact of what was planned.

The initial screening-scoping during the RRAs 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.

N3 PEP OF CHALAN BEEL POLDER D

N3.1 Agroecological Divisions

Table N1 and Figure N2 present the four AEDs defined in Chalan Beel Polder D. These are:

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

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

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

AED D - Perennial wetlands and waterbodies: some old river channels and the larger khals, but primarily the true perennial beels (11 per cent), such as Hilna, Monki, Uthrail and Katigram in the west and Maller, Joka, Jaypura and Haker in the east (note that a number of large beels

occurred pre-project along the Sib river outside the present bund e.g. Manda, Andasora, Chanditora, Jaonlal).

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

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

Table N.1 Chalan Beel D: Agroecological Divisions

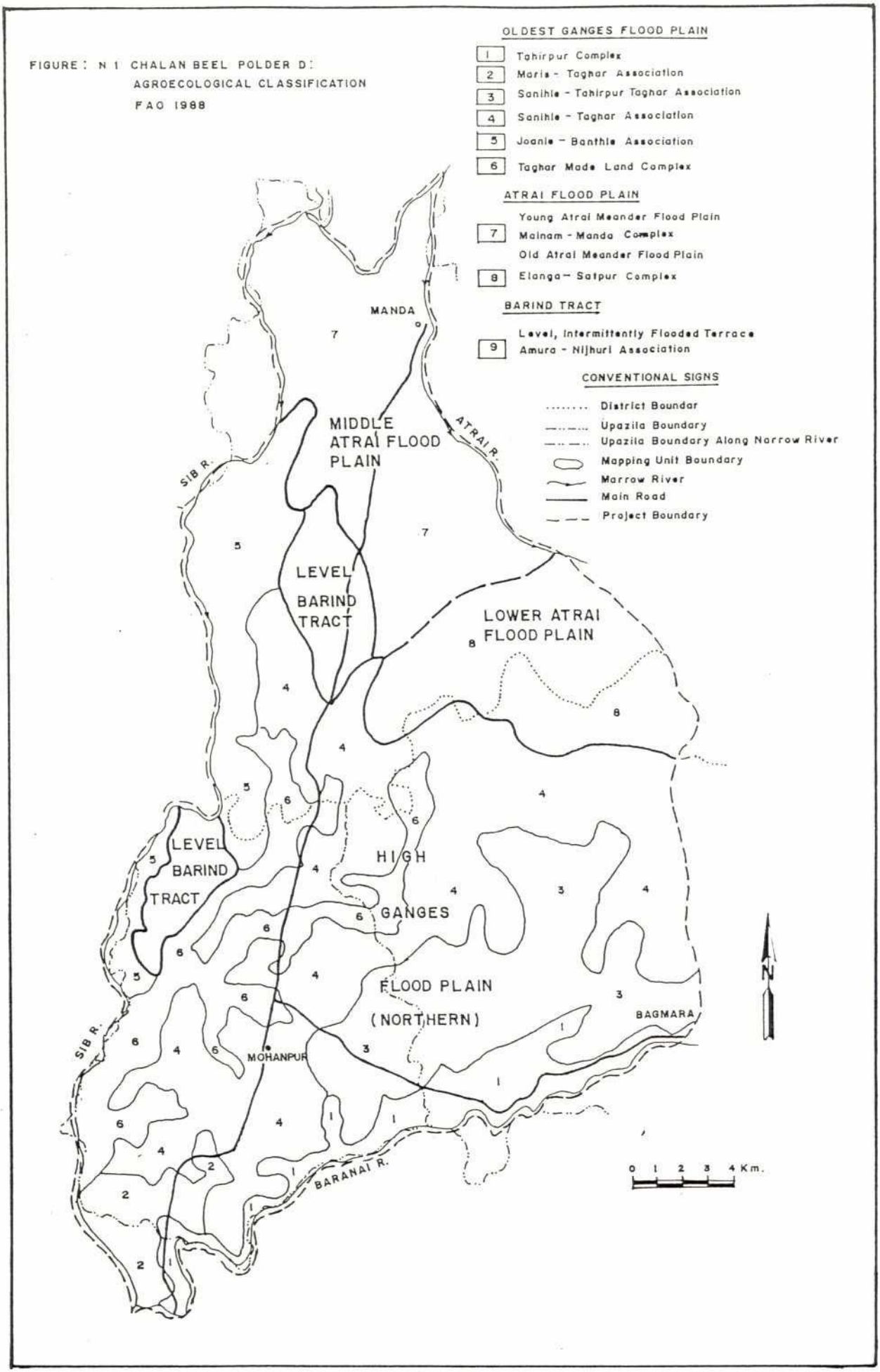
Agroecological Region	Agroecological Subregion	Soil Association	% of Area	Dominant Land Types*
11. HIGH GANGES RIVER FLOODPLAIN	116. NORTHERN HGRF	Gh 191	6	H
		Gh 192	3	MH
		Gh 202	13	ML-H-MH
		Gh 207	26	ML-MH-H
		Gh 209	8	L-ML
		GH 193	10	H
		66		
3. TISTA MEANDER FLOODPLAIN	3f. Middle Atrai Floodplain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

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

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

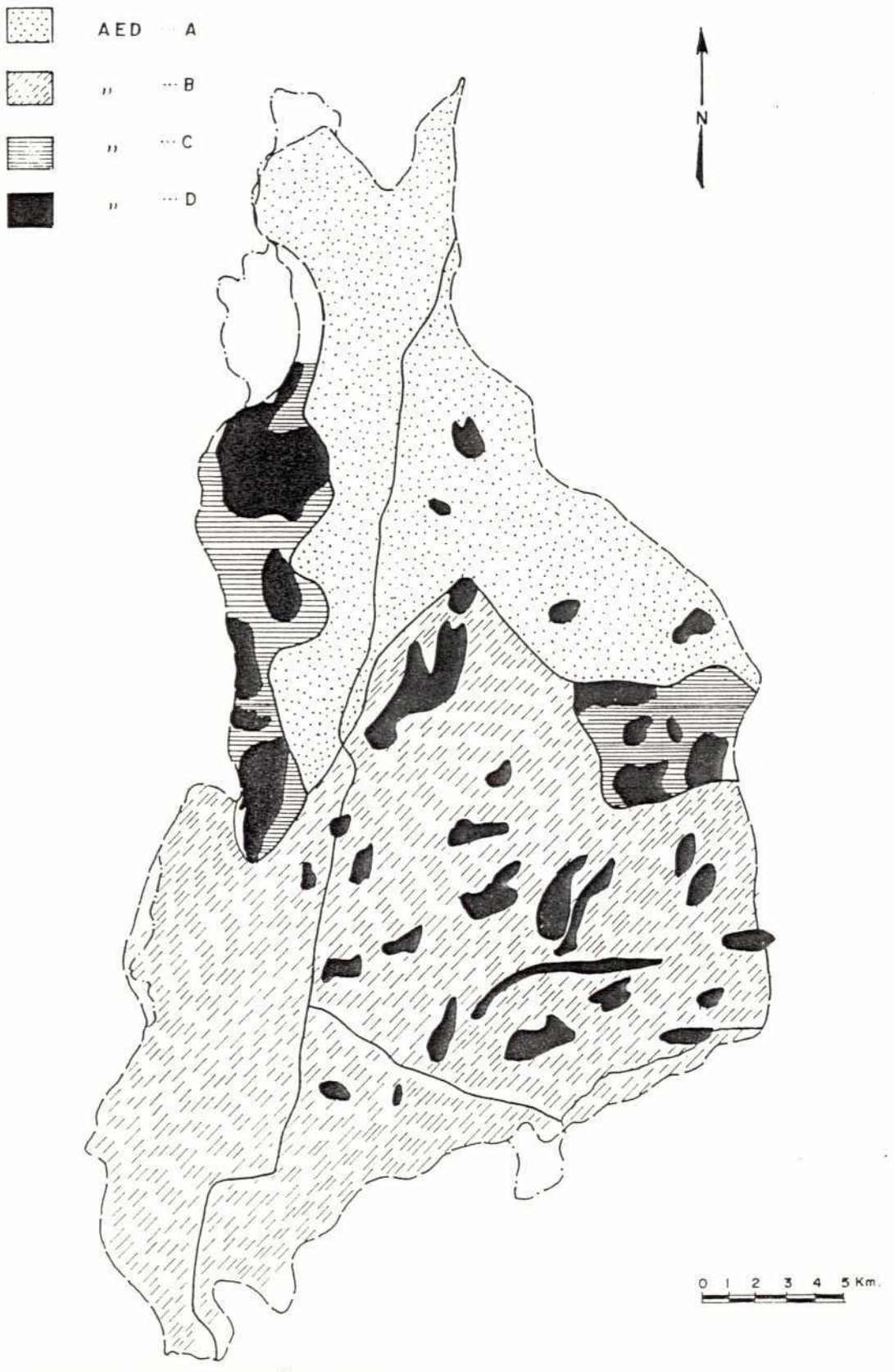
Source: FAO, 1988

FIGURE : N 1 CHALAN BEEL POLDER D:
AGROECOLOGICAL CLASSIFICATION
FAO 1988



Source : FAO, 1988

FIGURE: N 2 CHALAN BEEL POLDER D: AGROECOLOGICAL DIVISIONS



DERIVED FROM BETS/DPC, 1989

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

AED D formerly accounted for a very substantial part of the Project Area, occupied by various forms of wetland. As mapped in Figure N2, the division comprised essentially permanent wetlands. Pre-project it seems that these still retained some natural ecological qualities, in terms of fauna and flora, with fish in particular having considerable socio-economic importance. The fish communities, however, had been declining for some years, especially in the main western tract of AED D, due to the total closure of the Sib river just below its exit from the main Atrai River, at Baidypur Bazar. The local people originally built an earth barrier as early as 1959, which BWDB reinforced with a concrete structure in 1977/8. Fishing was the only major land use.

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

The agroecological divisions used within the Project Area are the four AEDs defined above, with external (off-site) impact areas defined below in Section N3.2. The application of the AEDs requires clarification. Agroecological Divisions are dynamic, changing especially in response to human influence. Thus AED D, the permanent wetlands, is now much reduced in extent compared with pre-project (Figure N2). FAP 12 evaluation must be with conditions as they would have been now, given pre-project trends. Thus impacts assessed now for AED D have to be evaluated in terms of the changes that have occurred within AED D as mapped in Figure N2, as this would have remained the extent of the AED without the Project.

N3.2 External Areas

External areas affected by Chalan Beel D can be grouped under three headings: Sib River; Atrai-Fakirni-Barnai Rivers; and the downstream Lower Atrai Basin.

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

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

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

N3.3 Environmental Screening

The primary project activities of Chalan Beel Polder D were flood protection, drainage and controlled run-off retention for irrigation. The scoping exercise (reported in detail in the Chalan Beel PIE Report) showed that none of these has been fully achieved. The threat of catastrophic flooding remains, albeit on a generally more localised scale, during really wet years, due to cuts and breaches. Drainage systems are suffering from siltation and poor operation and maintenance of khals and structures. Run-off retention for irrigation is locally successful and in general the embankment must slow run-off to some extent, although without allowing any control.

The environmental screening of project activities shows that the component responsible for most environmental impacts, positive and negative, is flood protection. Drainage and controlled run-off retention at present appear to be largely ineffectual.

N3.4 Findings

Conclusions can be summarised in terms of the main environmental impacts of the Chalan Beel D Project on the Project Area and on the external impact areas. Environmental impacts have been assessed by environmental scoping and are presented in Tables N2-N4. The AEDs to which they refer are defined in Figure N2 and Table N1.

N3.4.1 The Project Area

There have been no major and only two moderate positive net impacts in the Project Area overall. The latter were the impact on flooding and the increased land availability especially in AEDs C and D. Most positive impacts are only minor, partly because the Project had only been in operation for five years prior to 1991 but particularly because it has failed in critical wet years (notably 1987 and 1988) to achieve its planned objectives. This has been due largely to public cuts in the embankment and occasional natural breaches due to poor design and construction, as well as to inadequate drainage causing drainage congestion within the bunds.

The main negative impacts overall have been:

- the decrease in wetlands and consequent decline in the communities and habitats of fish and aquatic micro-biota and vegetation (AEDs D and C);
- the resulting decline in capture fisheries (AEDs D and C);
- marked deterioration in social cohesion and equity (AEDs C and especially D);
- the failure to achieve institutional effectiveness and to encourage public participation (AEDs C and D);
- the threat to the cultural traditions of the largely Hindu capture fishermen (AED D).

Table N2 Physical Environmental Impacts.

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

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

Source: Consultants

Table N3 Biological Environmental Impacts

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

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

Source: Consultants

Table N4 Human Environmental Impacts

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

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

AED A has not been significantly affected because it was rarely seriously flooded pre-project. In AED B, the basins have generally had similar impacts to AED C and the ridges to AED A.

N3.4.2 External Impact Areas

Tables N2 - N4 show clearly that the Project has had much greater negative impact beyond its boundaries, in the adjacent Sib area and especially in areas downstream in the Atrai Basin. Many of the impacts in the latter areas are attributable to the collective impact of the Middle Atrai polder schemes, of which Chalan Beel D is one. However, the cumulative off-site environmental risk implicit in these schemes is such that they must be assessed collectively, to reveal the considerable environmental hazards involved.

There are no moderate or major positive impacts due to the Project in the external areas, and very few minor ones.

The Sib area suffers numerous moderate negative impacts and occasional minor ones (Tables N.2-N.4). Problems arise primarily due to the embankment creating a barrier to run-off from the Barind Tract in the west and to high river levels in AFB Rivers preventing any real flow in the series of beels that was once the Sib River.

The active floodplains of the AFB Rivers, contained within parallel bunds, have not benefitted from the Project but suffer a number of moderate negative impacts, due largely to higher river levels.

It is in the downstream areas in the Atrai Basin that the majority of severe impacts arise (Tables N2-N4). Concentration of river flows and prevention of flood attenuation in the Middle Atrai creates major threats downstream of catastrophic flooding, even in years that are well within the theoretical design of downstream projects (because these are individually calculated in situ for each project, thus ignoring the cumulative upstream threat).

As a result, cropping, infrastructure, population capacity, health, social disruption and even survival, social cohesion and attitudes, economic parameters, public participation, and the overall quality of life all suffer serious negative impacts. The events of 1987, especially bad in the North West Region, and 1988 were representative of many of these negative impacts. They will recur, and more frequently, if the uncoordinated empoldering of the Middle Atrai continues.

N4 PEP OF KURIGRAM SOUTH UNIT

N4.1 Agroecological Divisions

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

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

Within the Tista Meander Floodplain AER, FAO have defined a number of agroecological subregions (AES), of which two occur in Kurigram South: the Central and Eastern TMFPs. Table N5 summarises the FAO classification within the Project Area, including the nine soil associations mapped by FAO.

The FAO agroecological classification, therefore, provides a broad spatial framework for environmental assessment both before and after the FCD/I Project, especially when related to the pre-project flood depths given in Table N5. As mapped by FAO at a scale of 1:750,000, however, the framework is inevitably imprecise for assessment purposes. One of the chief aims of the environmental fieldwork was to establish agroecological divisions (AED) derived from the FAO classification but creating units which relate directly to pre-project (and post-project) environmental conditions (Table N5). The FAO mapping was then refined to delineate the AEDs at the FAP 12 map scale here of 1:150,000 (Figure N3).

Six AEDs have been defined and are illustrated schematically in Figure N4. Pre-project conditions in each are discussed below:

AED A: Kurigram Ridge

AED A extends westwards from just beyond Kurigram town, covering about 6 per cent (3,900 ha) of the Project Area. It consists mainly of Highland, with some Medium Highland, forming a smooth ridge. Flooding in pre-project times was restricted largely to the peripheral lower slopes of the ridge and even there was of limited depth and duration. The land was above most river floods and rainfall either ran off the high land or percolated rapidly into the very permeable soils. Only a thin surface horizon of silty soil overlies the dominantly sandy subsoil and substratum in this area.

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

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

Table N.5 Kurigram South: Agroecological Classification

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

Agroecological Divisions (FAP 12)	A	B	Bo	C	D	E	R
Approx. % of Area	6	15	(2.5)	37	29	5	8

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

Source: FAO, 1988 and FAP 12.

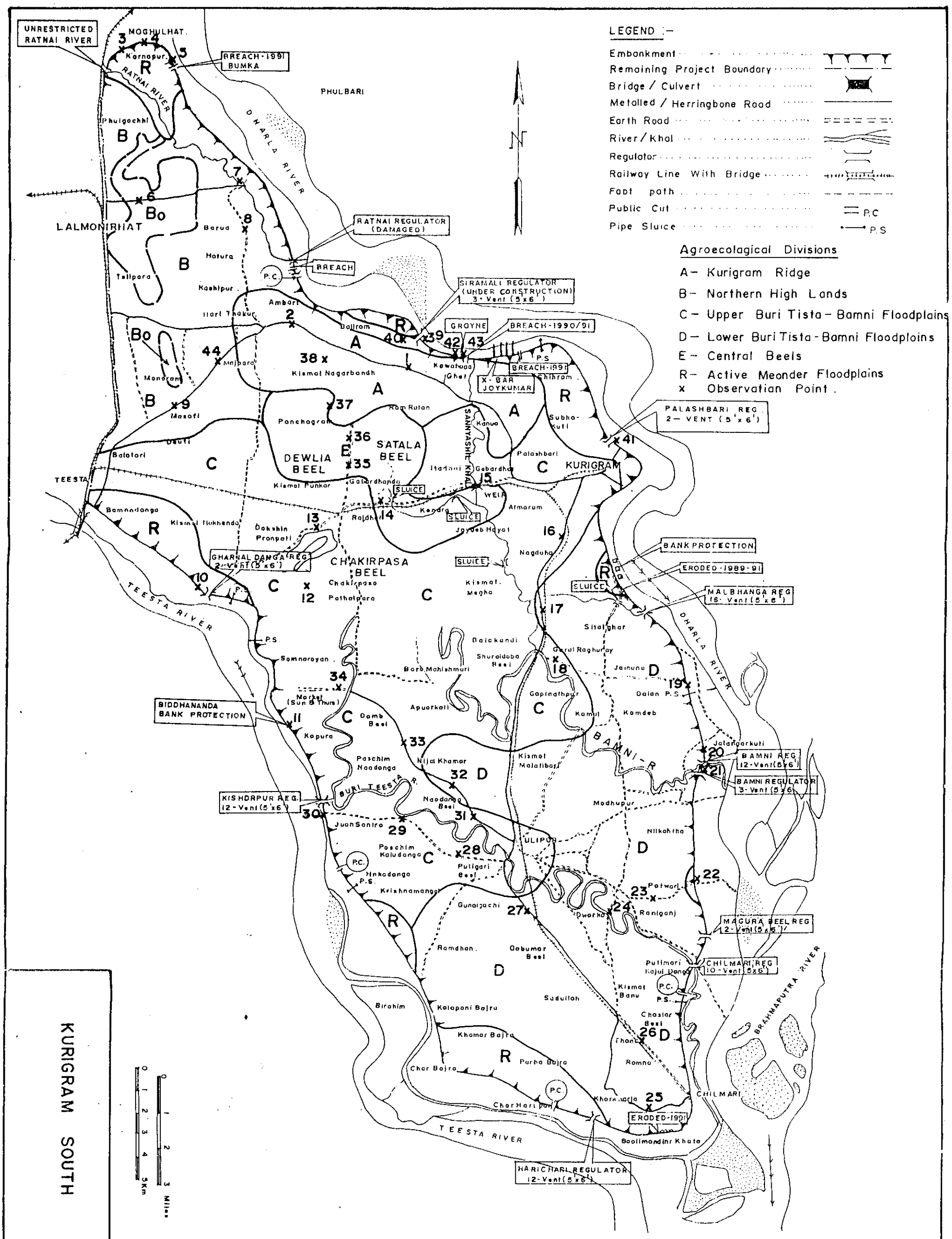
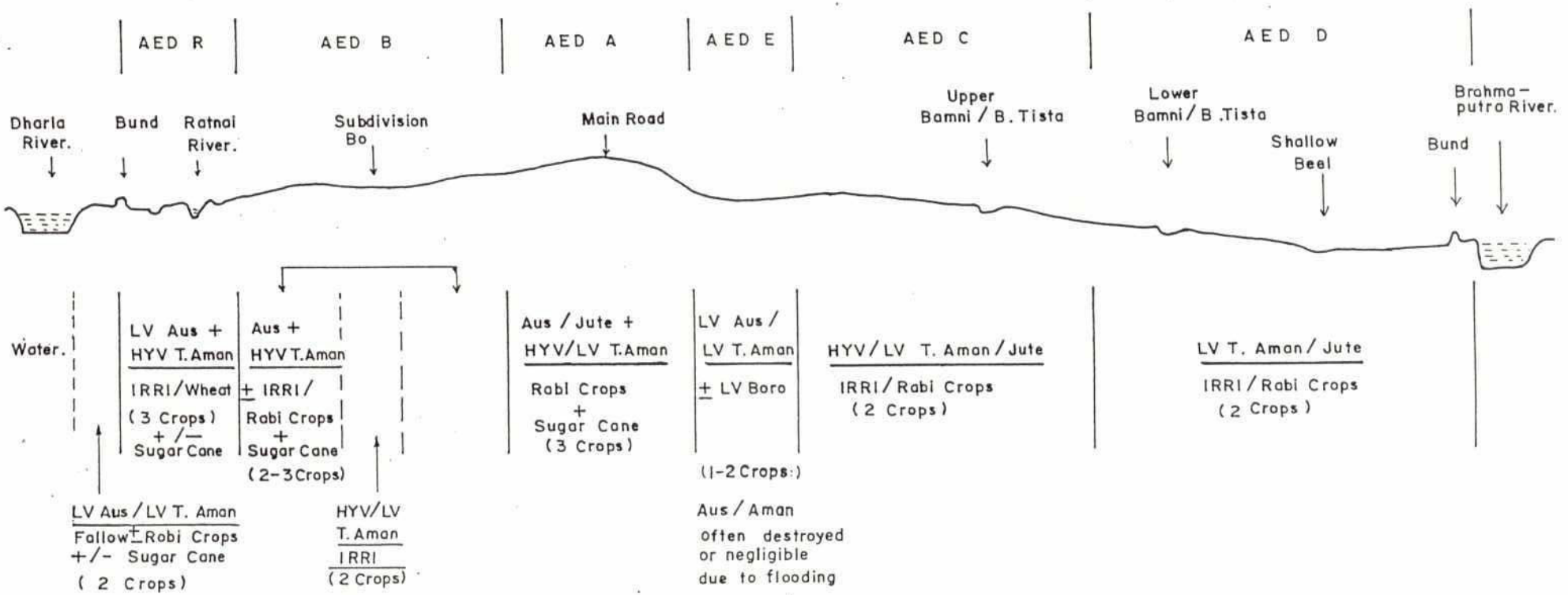


FIGURE N3 AGROECOLOGICAL DIVISIONS AND OBSERVATION POINTS.

FIGURE: N4 **KURIGRAM SOUTH: AGROECOLOGICAL DIVISIONS (AED)**



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

D 04

AED B: Northern High Lands

To the west and north, AED A is surrounded by land of more varied relief, comprising a series of ill-defined low ridges and small, very shallow basins. As Table N5 shows, there is still considerable Highland, but with Medium Highland dominant. Within AED B there are also two mappable extents of well-defined, near-level basins which form a distinctive unit. It is too small to separate out as another AED and so is included as an agroecological, subdivision of AED B, Subdivision Bo. AED B accounts for 15 per cent of the FCD/I Project Area (9,750 ha), of which Subdivision Bo comprises 2.5 per cent (1,600 ha).

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

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

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

AEDs C and D: Buri Tista-Bamni Floodplains

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

In pre-project times it would probably not have been justified to separate AEDs C and D. Together they comprise FAO's soil association Tm 162 (Table N5) and form part of the lower, flatter Eastern Tista Meander Floodplain AES. They cover 66 per cent of the Project Area (about 43,000 ha).

Soils here have substantial thickness of silty topsoil and subsoil, with sandier substrata. Table N5 shows relief to consist mainly of MH2 land type, implying moderate flooding. This accords with the view of the Feasibility Report (Techno Consult Eastern Ltd, 1975) that the Dharla River usually flooded mainly on its left bank, while the Tista flooded regularly only along its lower left-bank reaches. Much of the flooding in AEDs C and D in fact, resulted from rainfall and run-off from the much higher land to the north (Figure N.4).

The topographic and consequent pre-project land use patterns were better defined than in AED B, with flat-bottomed rice basins surrounded by low ridges where settlement and

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

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

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

AED E: Central Beels

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

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

AED R: Active Meander Floodplains

About 8 per cent of the Project Area (5,200 ha.) consists of the active meander floodplains of the Tista and Dharla Rivers, with even a small tract of Brahmaputra (Jamuna) active meander floodplain in the south east. Given the size and strength of these rivers and the wholly unsatisfactory nature of the sandy active meander floodplain alluvium for bund construction, it would seem that the engineering planning and design can only have ignored the soil maps and data that were available to them. It is unlikely that in the long term any embankment can be sustained within the active meander floodplains except at exorbitant cost in materials and effort, and at no little risk.

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

Land use pre-project in the Dharma and Tista active meander floodplains within the Project Area was fairly intensive, as it is today in their riverine areas (see Section 10.3.3). Local Aus and Aman were grown, with sugar cane widespread in many parts. In the dry season, the sandy soils were difficult to cultivate for rabi crops except where water was within

easy access. The silty topsoils found in the Tista Meander Floodplain are very thin and discontinuous or absent altogether in AED R.

The agroecological divisions used within the Project Area are the six AEDs defined above with external (off-site) impact areas defined below in Section N4.2. Agroecological divisions are dynamic, changing especially in response to human influence. However, in Kurigram South it is indicative of the limited agroecological impact of the Project that the boundaries of the AEDs defined above to illustrate pre-project conditions remain the same today. Possibly AEDs C and D might have formed a single AED pre-project, as noted.

N4.2 External Areas

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

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

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

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

The Brahmaputra Riverine Area occurs to the south east and south of the Project, with cultivated and settled land along the south east margin but only limited setback in the south.

N4.3 Findings

Conclusions can be summarised in terms of the main environmental impacts of the Kurigram South FCD/I Project on the Project Area and the external riverine areas. Environmental impacts have been assessed by environmental scoping (described in detail in the Kurigram PIE report) and are presented in Tables N.6-N.8. The agroecological divisions (AED) are defined on Figure N4 and in Table N5.

N4.3.1 The Project Area

There have been no major positive impacts in the Project Area as a whole and the only overall moderate positive impact has been on social attitudes: people, especially in the lower areas, feel that the Project provides security from floods.

Table N.6 Physical Environmental Impacts.

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

Source: FAP 12

Table N.7 Biological Environmental Issues

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

Source: FAP 12

Table N.8 Human Environmental Issues

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

Source: Consultants

There are also no major negative impacts overall, and only two moderate negative impacts taking the Project Area as a whole. The latter in fact are contradictory to the positive impact noted above, in that they relate to increased danger of catastrophic flooding and the BWDB's likely inability to do much to prevent it (due mainly to technical difficulties and excessive costs, rather than any failure by BWDB).

There are four areas of particular concern in relation to catastrophic flooding risk:

i. the general weakness of the embankment throughout the Project Area;

ii. the particular weakness and vulnerability in the AED R tracts;

iii. Kishorpur Regulator, where there is a danger that the Tista could re-enter the Buri Tista channel;

iv. Sannyashil Khal "confluence" with the Dharla, where the Dharla could enter the khal channel and penetrate the Project Area.

The limited impact on the Project Area overall results from the following:

i. pre-Project flooding was a problem in only 40 per cent of the Project Area and even then was in large part due to heavy monsoon rainfall and run-off within the Area;

ii. natural breaches and public cuts are common, allowing many lower localities to be flooded still; the increased danger of catastrophic flooding is noted above;

iii. drainage congestion due to inadequate sluice design and distribution has resulted in lower areas, especially near the embankment (AED D), suffering worse flooding than pre-Project;

iv. overtopping of the inadequate railway embankment in the north west continues as it did pre-Project;

v. lack of maintenance of the drainage channels has reduced effective drainage, especially in the central beels (AED E);

vi. no irrigation component has been implemented, although the possibility remains that a totally unsuitable surface irrigation scheme could be imposed on the area. The scope for further tubewell irrigation development is evident;

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

From points (i) - (v) above it can be seen that the Project's overall impacts have a marked variability in their geographical distribution within the Project Area. The AED approach was devised to illustrate this variation.

Thus it is clear that the Kurigram Ridge (AED A), representing 6 per cent of the Project Area, has been barely affected by the Project and the Northern High Lands (AED B 15 per cent) only slightly so.

The extensive Upper Buri Tista-Bamni Floodplains (AED C 37 per cent), on the other hand is the AED to have most clearly benefitted, with significantly reduced flooding allowing a large-scale switch from local to HYV Aman rice.

The similarly extensive Lower Buri Tista-Bamni. Floodplain (AED D: 29 per cent) and the more localised Central Beels (AED E: 5 per cent) have received both positive and negative impacts, with the former sufficient to create a net minor positive impact in both areas.

In many ways the most critically affected AED consists of several small tracts of Active meander Floodplains (AED R: 8 per cent), nearly all along the Tista and Dhonagoda Rivers. These have been erroneously included in the Project Area and represent some of the main areas of catastrophic flood hazard, which can only be avoided by protective works out of all proportion to the returns from the limited extents of land protected. The high degree of risk implies an overall negative environmental impact for AED R.

N4.3.2 External Impact Areas

Tables N.6-N.8 show the general minor negative physical and human impacts of the Project on the adjacent riverine areas along the Tista, Dharla and Brahmaputra Rivers. There have been negligible biotic impacts there.

The basic cause has been the slight increase in flooding resulting from the embankment preventing the spread of rising river waters over the adjoining Project Area.

Any cumulative downstream effects of the Project, in association with other FCD projects upstream, are completely masked by the sheer size of the Brahmaputra River flows, largely arising outside Bangladesh.

N5 PEP OF MEGHNA-DHONAGODA IRRIGATION PROJECT

N5.1 Agroecological Divisions

The Meghna-Dhonagoda Irrigation Project (MDIP) was constructed over a period of nine years, from 1978 to early 1987. Thus there have been five monsoon seasons to date, including the exceptional 1987 and 1988 years. The main components planned were irrigation, based on two main pump stations and two internal booster stations, and a network of mainly gravity flow canals; flood protection, from a perimeter embankment; and drainage, along both artificial channels and natural khals, removed by pumping from the two main stations. Other components were to have included navigation locks through the embankment, agricultural and fishery support through a pilot farm and strengthened extension services, and a comprehensive internal roads system; none of these have materialised. MDIP, therefore (and despite its name), is an FCD/I project, but with much more emphasis than usual on irrigation.

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 MDIP the relevant soil survey took place in 1967 and was revised in 1971. 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 during the RRA and environmental field visits in March-April and November, 1991, and from the sources noted in Section 10.3.6.

The MDIP Area forms an island between weakly tidal stretches of the Meghna River and of its anabranch formed by the Dhonagoda and Gumti Rivers. The whole area falls within FAO's Middle Meghna River Floodplain AER. This occurs where young Meghna alluvial sediments have partially buried what was the active meander floodplain of the Brahmaputra River until about 200 years ago. Thus the land comprises old sandy chars, with variable depths of younger and finer sediments deposited on them.

The result is a variable pattern of ridge-and-trough topography throughout the Project Area, so that the typical saucer-shaped relief of many FCD projects does not occur. The peripheral rivers have not as yet had time to establish commanding levees to form a central depression, although the process has begun. As a result there are no large beels in the area.

FAO does not attempt to differentiate AES in this complex landscape, although a degree of correlation between their soil associations and subtle but distinctive topographic patterns have been established in the Project Area (Table 10.1). These form agroecological divisions (AEDs), as defined by FAP 12 (1991b). They are mapped in Figure 10.1 and the different characteristics of the AEDs are schematically illustrated in Figure 10.2. The refinement by FAP 12 reflects the very small scale (1:750,000) of the FAO soil maps, compared to the FAP 12 scale here of 1:75,000.

Pre-project conditions in the three agroecological divisions (AEDs) are discussed below. The nomenclature is from FAP 12, as FAO had not established any at this level. Differences between the three AEDs are not as marked as in the other FAP 12 PIE areas.

AED A: Old Meghna Floodplain

The Old Meghna Floodplain (AED A) occupies the north of the Project Area, accounting for 43 per cent (about 7,600 ha.) of the total area. It has marginally the highest average elevation (mostly 2-4 m. above sea level) in the Project Area but differs from land further south more in its distinctive, regular terrain of narrow ridges and wider, parallel troughs (Figure N.6) forming an obvious pattern tending north-north-west to south-south-east.

AED A consists wholly of FAO's Soil Association Mm 769, in which the narrow ridges were almost entirely occupied by settlements, even pre-project. ML land slopes down to form the troughs, with a narrow bottomland of Land Type L, in which a small north-flowing, seasonal khal often occurred. It is possible that this topographic pattern has been largely created by man, with the ridges consisting mostly of made land.

Table N.9 Meghna-Dhonagoda: FAO Agroecological Classification

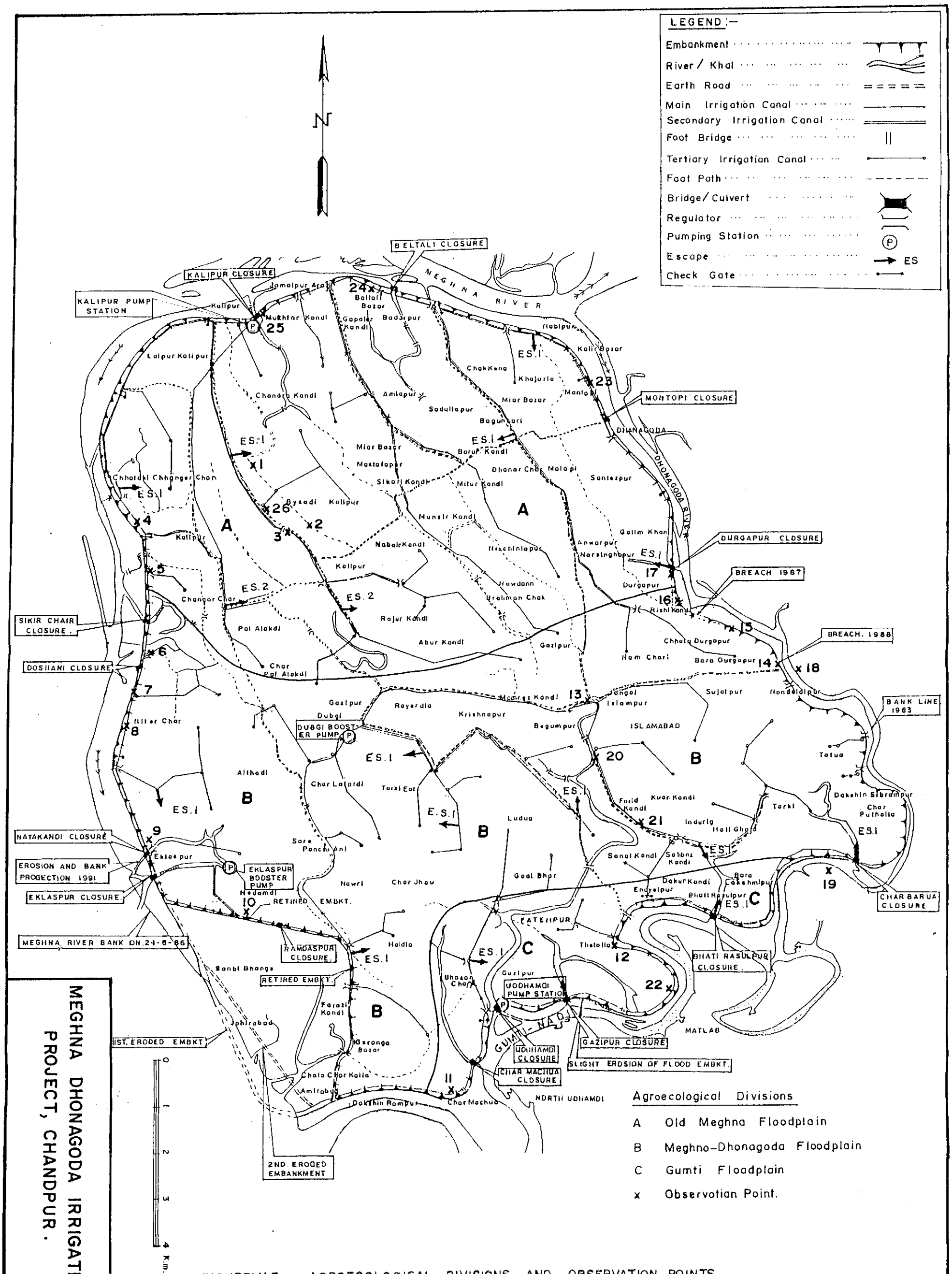
Agroecological Region	MIDDLE MEGHNA RIVER FLOODPLAIN		
Soil Association	Mm 769	Mm 771	Mm 770
Approx % of Area	71	22	7
Land Types (Flooding - cm)	%	%	%
Settlements	18	12	25
H (0)	0	0	0
MH1 (0-30)	0	0	0
MH2 (30-90)	0	0	0
ML (90-180)	65	75	53
L (180-300)	17	13	22
VL (300+)	0	0	0
Total	100	100	100
Agroecological Division: FAP 12	A	B	C
Approx. % of the Area	43	50	7

Sources: FAO, 1988 and Consultants

In pre-project times, flooding by the tidal rivers and heavy rainfall (about 2,300 mm per year) badly affected all but the narrow ridges, which only suffered in the highest floods (Table N.9).

Soils are classified by FAO (1988) as Noncalcareous Grey Floodplain Soils (Eutric Gleysols). The highest ridge soils are probably anthropic. On the ridge flanks silt loam and silty clay loam are dominant in the upper soil layer, grading down into silty clay or clay on lower slopes and bottomlands. Topsoils are strongly acid due to rice cultivation (pH 4.5 - 5.5) but become less so in the subsoil (pH 6.0 - 7.0). A key soil variable is depth to any underlying sandy Brahmaputra alluvium. The sandy nature of the canal dykes in this area suggested that the finer-textured upper layer of soil was of limited thickness.

Land use pre-project faced deep flooding of uncertain timing and duration. As a result only one rice crop was possible on a given piece of land. This was mostly B. Aus or B. Aus-B. Aman mix on the upper slopes, with B. Aman downslope. In the lowest, wettest areas LV Boro was grown on residual water. There was only very limited irrigation development, with traditional manual lift methods increasingly supplemented by LLP, using khal water. Additional rabi cropping following the Aus/Aman crops seems to have increased steadily over the long period of construction, comparing the Feasibility Study (Chuo Kaihatsu, 1977) and the CIRDAP (1987) socio-economic baseline. By 1987 considerable areas of wheat, potato, pulses, oilseeds, vegetables and perennial sugar cane were grown. The increased rabi intensity probably reflected the growing use of LLP irrigation. Jute declined in importance, as elsewhere in Bangladesh, over the same period but was still a common alternative to Aus in early kharif. There was virtually no use of HYV rice varieties and the inputs associated with them.

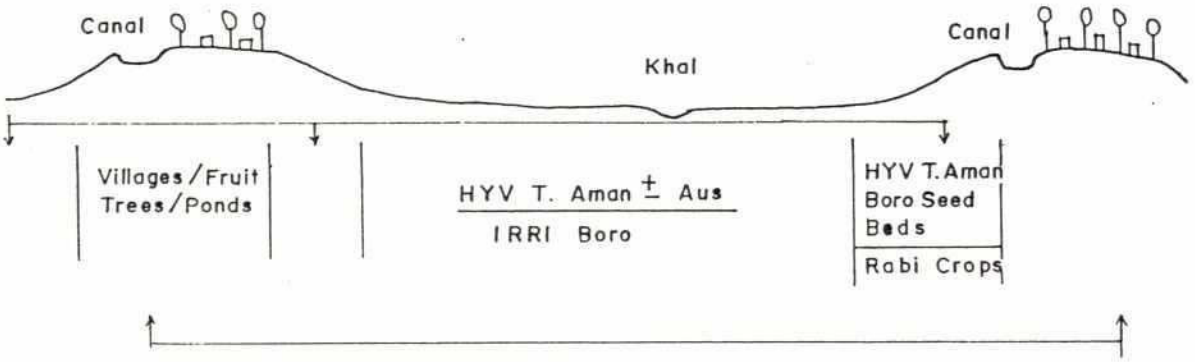


MEGHNA DHONAGODA IRRIGATION PROJECT, CHANDPUR.

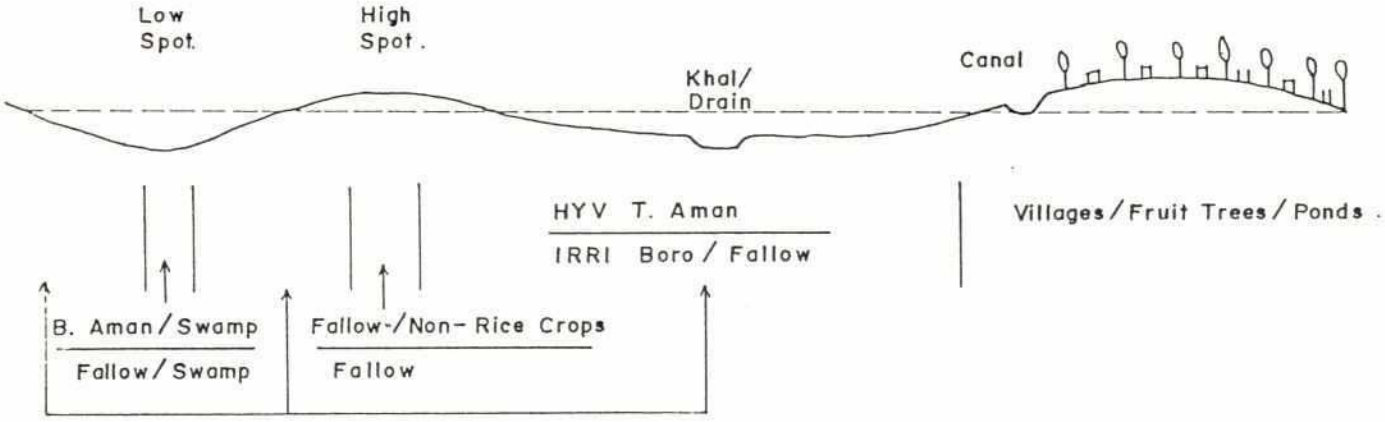
FIGURE: N 5 AGROECOLOGICAL DIVISIONS AND OBSERVATION POINTS.

FIGURE : N 6 **MEGHNA — DHONAGODA : AGROECOLOGICAL DIVISIONS (AED)**

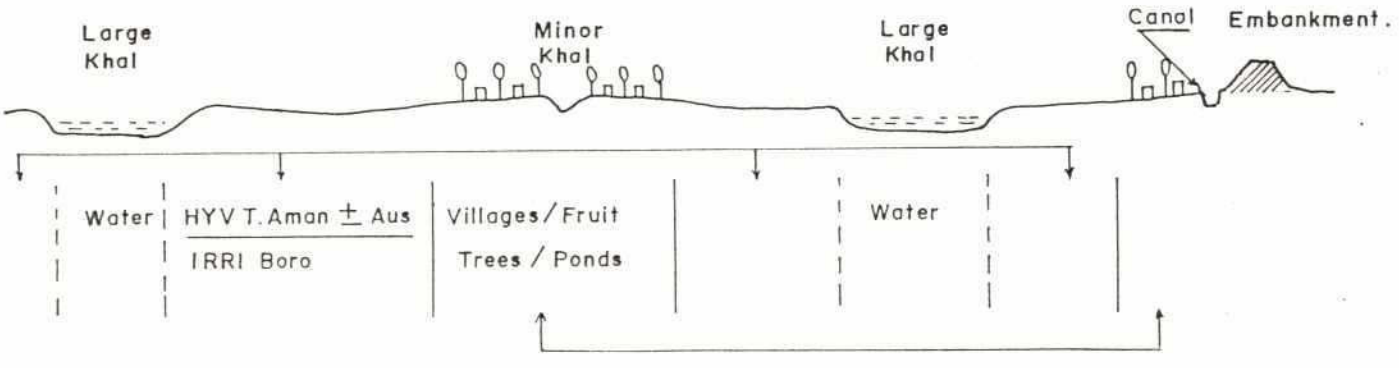
AED A : Old Meghna Floodplain



AED B : Meghna — Dhonagoda Floodplain



AED C : Gumti Floodplain



Cattle and other livestock were grazed on the rice stubble in rabi and on rabi crop residues when they were harvested. Capture fisheries must have been dependent mainly on the adjacent rivers, as the regular alternation of relief created few true seasonal wetlands of any size. No beels of any size are mapped on the old 1:50,000 topo-sheets, but only narrow strips of temporary wetland along the trough bottoms. Fishing in the interior was very much a secondary occupation, mainly harvesting river fish trapped in localised depressions, ponds and khals. There was no sizeable traditional fishing community away from the rivers.

AED B: Meghna-Dhonagoda Floodplain

AED B occupies most of the central and southern of the Project Area, apart from the south-east corner (AED C). Altogether it covers 50 per cent (some 8800 ha.) of the total area. It seems to have been an area of deeper and longer flooding then AED A, in that the terrain is much less regular. Villages are noticeably less linear and the intervening relief includes both high and low spots (Figure N.6). It is ridge-and-basin rather than parallel ridge-and-trough terrain, with the basins more extensive than the northern troughs. Even so, there are again only sporadic, small seasonal patches of wetland. None of the basins is large or deep enough to create a genuine beel. The pattern of khals, here draining mainly to the south, is correspondingly confused and irregular. Pre-project the khals were subject to weak tidal influences, but were never threatened by salinity.

Despite these subtle topographic difference, the amplitude of the relief, soils and the degree of flooding were much the same as in AED A. Much of AED B is occupied by the same Soil Association (Mm 769) as AED A, but it also includes Mm 771. The latter has a slightly higher combined proportion of ML and L lands (Table N.9), which reflects the larger extent of the basins compared to the northern troughs. Mm 771 soils, in fact, seem more representative of AED B. It seems likely that the masking layer of finer-textured upper soil overlying sandy char material might be slightly thicker in the basins of AED B.

As a result of this lack of major physical differences, pre-project land use was also similar, with rice or sometimes jute followed by a variety of rabi crops or, in the lower parts, LV Boro rice. The same limited use of irrigation occurred, mainly for rabi crops, with HYV varieties rarely to be found. Livestock and fishing were perhaps slightly more important in the larger basins but again the lack of any major beels meant that capture fisheries relied more on the adjacent rivers and on khals and ponds within the Project Area.

Communications were less straightforward as village roads had to cross or skirt basins, so that small boat transport was important during the floods.

AED C: Gumti Floodplain

AED C is of limited extent, only 7 per cent of the total (or about 1200 ha.). It occupies the south east of the Project Area, along the right bank of the Gumti River. The distinctive feature of AED C are the numerous large khals that occur, seeming to be formed often in old channels and meander scars of the Gumti or its ancestors. Again, pre-project they were weakly tidal but fresh, and so important waterbodies.

Relief seems more subdued and is dominated by the old channels. Village settlement appears to follow the minor khals, again possibly on anthropic "levees", while avoiding the banks of the large channels.

AED C coincides with FAO Soil Association Mm 770. This shows a higher density of settlement (possibly influenced by proximity to Matlab and its ferry) and consequently slightly less ML and L land. Even so, in pre-project times it seems likely that flooding along the large channels would have been as much a problem as elsewhere in the Project Area. Soils seem not to differ significantly from AEDs A and B, except perhaps for thinner superimposed finer sediments in what appears to be a relatively younger landscape.

As a result, the land use pre-project perhaps had different emphases than further north, although following a similar overall pattern. Fishing was likely to have been significantly more important than in the interior. In addition to the adjacent river fisheries, the large channels and close network of interlinking khals must have formed valuable fishing grounds within AED C. Grazing may also have been slightly more important, on seasonally flooded land alongside the channels. The opportunity for LLP and other methods of lift irrigation was substantially greater.

N5.2 External Areas

There are only two external areas affected by MDIP:

- Meghna Riverine Area (MRA)
- Dhonagoda-Gumti Riverine Area (DRA)

The Meghna River flanks the MDIP to the north and west, as a major river around 5 km. in width. It seems unlikely that the Project could produce a significant impact upon a river this size, or the land beyond it, especially as it is not surrounded by similar projects creating the sort of cumulative impact found in the Atrai Basin or the Lower Ganges system. Impacts are therefore identified only in the setback land, between the Meghna and the embankment. This is fairly intensively cultivated and settled but where the Meghna gets bigger, along the western flank, the setback is subject to persistent bank erosion and loss of land. Erosion is especially fierce in the south west, where the embankment has already had to be retired twice south of Eklaspur. The setback is about 200-300 m wide in the north east but west and south from Kalipur it is 600-700 m. The new tract created by the latest bund retirement in the south west covers a block of about 1000 ha., but this is being reduced by bank erosion. A problem for this area is that it is more or less opposite the confluence with the huge Padma River and therefore at an obvious point for bank erosion.

The Dhonagoda in the east and its continuation as the Gumti on the south form a much smaller river than the Meghna, but still one capable of large floods and considerable erosive power. Setback is never more than 200-300 m. and is often almost non-existent. There is some cultivation and occupation, but a large part of the impacted area consists of the adjacent unprotected lands across the river, on both the east and south.

No downstream impacted area is considered, for the reasons already noted concerning the proportional size of the Meghna, especially below the Project Area, after it is joined by the joint flows of the Brahmaputra and Ganges (the Padma River) to form one of the largest rivers in the world.

N5.3 Environmental Screening

Environmental screening is based on scoping to evaluate project activities in terms of their influence on environmental impacts; the scoping for the MDIP PEP is described in detail

in the MDIP PIE. The Project's primary activities were flood control, drainage and irrigation. Scoping shows that since 1988 the flood control and irrigation components have been achieved largely as planned, but that in the two years of the Project prior to that, major negative impacts resulted from catastrophic breach flooding, especially in AED B. Also, prior to 1987 during the construction period, about 1,000 ha of badly selected land in the south west was lost to natural bank erosion by the Meghna.

Thus flood protection failed initially but has since helped to achieve large positive impacts. These are qualified, however, by considerable immediate and long-term risk hazards in the east and west respectively of AED B.

Irrigation, in the meantime, has been largely responsible for the major agricultural and economic impacts and could probably have been possible without flood protection. Irrigation has focused, however, on HYV paddy rather than on increasing high-value rabi crop production, as originally planned (due partly to BWDB's failure to levy any water rate).

The drainage component, despite being the major operational expense element, contributes much less to the major positive impacts than irrigation. With flood control, it provides benefits during the kharif season. Although expensive, it does in general avoid the drainage congestion problems found in all other PIE studies.

The agricultural support, roads and navigational components originally planned were not implemented and so create no impacts.

N5.4 Findings

Findings can be summarised in terms of the main environmental impacts of the Meghna-Dhonagoda FCD/I Project on the Project Area and on the external riverine areas. Environmental impacts have been assessed by environmental scoping and are presented in Tables N.10-N.12.

The agroecological divisions (AED) are defined in Figure N.5 and in Table N.9.

N5.4.1 Project Area

Major positive environmental impacts have been achieved as follows:

i. improved soil moisture status, especially in AEDs A and C;

ii. improved land capability, also especially in AEDs A and C;

iii. greatly improved human carrying capacity, MDIP's most important achievement;

iv. favourable demographic impacts, reversing out-migration and stabilising demographic structure.

These are accompanied by number of moderate positive impacts, including:

i. almost complete control of flooding and drainage since 1988; this is not considered a major impact because of the initial failures in 1987 and 1988 and the considerable immediate and long-term risk hazards, especially in AED B;

ii. crop cultivation (and especially irrigation), where a major impact in recent years is again tempered particularly in AED B by the events of 1987-88 and the continued high risks;

iii. agro-industrial and associated activities, which have flourished following the increased agricultural production;

iv. an appreciative social attitude to the Project, despite the experiences of 1987-88 and the continuing risk;

v. considerable economic benefits for local people, in terms of income, employment, land values and credit availability; again since 1988 these have reached major impact levels but are modified, especially in AED B, by the problems in 1987-88 and in the continuing risk factor;

vi. quality of life, reflecting the same potentially major impacts in most of the above issues, qualified by the 1987-88 breach floods and the risk of recurrence that persists.

It is apparent that the positive environmental impacts of the Project were focused on the extensive AED A (Old Meghna Floodplain), covering 43 per cent in the north of the Project Area, and in the much small AED C (Gumti Floodplain - 7 per cent) in the south. AED B (Meghna-Dhonagoda Floodplain - 50 per cent) bore the brunt of the 1987 and 1988 catastrophic breach floods through its eastern embankment, where the immediate risk of recurrence persists, and of the Meghna bank-erosion in the south-west, where a long-term risk continues.

The main socio-economic gains are related primarily to the irrigated rabi and Aus season crops, dominated by HYV paddy. Since this is likely to have been possible without the externally costly flood control and drainage components, the FCD impacts assessed alone would be less impressive, involving fewer and smaller impacts but still retaining the 1987-88 damage and the inherent risk element.

The other major negative impacts derive from this, consisting of the excessive soil erosion in the Dhonagoda embankment, especially between Nandalalpur and Durgapur (the stretch where both previous breaches occurred), and of the resulting major threat to human safety and survival.

Moderate negative impacts relate to the marked decline that is taking place in soil physical characteristics under the now-prevalent rice monoculture and to the limited involvement of the local people.

The main negative impact of the Project was poor institutional performance, especially during the design and construction stages, when embankment alignment in the south west, re-design of the embankment, and reliance on inadequate manual compaction techniques created the current high risk element. These shortcomings have been compounded by limited

embankment inspection and maintenance. A basic problem is BWDB's lack of resources for operating such a complex and threatened scheme.

Table N.10 Physical Environmental Impacts.

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

Source: Consultants

Note : ? = Uncertain impact.

Table N.11 Biological Environmental Issues

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

Note : ? = Uncertain impact.
Source: Consultants

Table N.12 Human Environmental Impacts

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

? = Uncertain Impact

Sources : Consultants

It is noticeable from Table N.12 that negative biotic impacts have been very limited. As in most of Bangladesh, ecological changes in the last few decades have been substantial in the Project Area. Such changes include the reduction in natural wetlands extent, accompanied by the marked decline in birds, fish and other wildlife. These had largely taken place in the MDIP Area by 1978, when project construction started and would have continued subsequently irrespective of the Project. In the last three years, fish disease has added a further marked negative trend, again apparently unrelated to the Project.

It is difficult to assess, therefore, the degree and additional impact when the Project's influence is superimposed upon these ongoing trends and the already dominantly anthropic landscape. Clearly, starting from such a biologically poor baseline as existed by 1978, overall biotic impacts are unlikely to be other than negligible or occasionally minor.

The physical and human environmental impacts are both frequently conflicting. Even the overall assessment of individual environmental issues is often a net value derived from both positive and negative significant impacts. This reflects the marked contrast between largely negative impacts arising during and immediately after construction, especially in 1987-1988, and the highly positive agricultural impact since then, but which is still tempered by the high risk factor.

A net overall assessment for the Project Area is best set at moderate positive, but is not very meaningful in view of the above.

N5.4.2 External Impact Areas

Tables N.10-N.12 also show the generally minor physical and human impacts of the Project on the external riverine areas along the Meghna and Dhonagoda-Gumti Rivers. There have been negligible biotic impacts there. The Project is not considered to create significant cumulative downstream impacts because it is not part of any close group of similar FCD Projects.

Most external impacts are negligible and some are minor, caused by the primary impact of slightly increased flooding against the embankments.

There is one moderate positive impact, on agro-industrial and associated activities in the Dhonagoda-Gumti Riverine Area (DRA), which have increased due to the rise in agricultural output and incomes in the adjacent Project Area. A similar impact occurs in the Meghna Riverine Area (MRA), partly due to increased activities of this type but due especially to long years of construction and reconstruction of the twice-retired embankment south of Eklaspur.

N6 PEP OF ZILKAR HAOR PROJECT

N6.1 Agroecological Divisions

Zilkar Haor FCD/I Project was completed in 1987, following three years of construction. 1991 is therefore the Project's fifth monsoon season, two of which saw the extreme conditions of 1987 and 1988. The embankments were not overtopped, breached or cut, even in those difficult years. The Project has a minor irrigation component, in which controlled inlet pipes

in the embankment provide irrigation via low-lift pumps from the rivers during the dry season. There is no roads component.

It is clearly important that the environmental evaluation assesses project impacts relative to what would have been the continuing pre-project trends, rather than to a specific point in time (1983). The main ongoing trend both before and after the Project has been the steady growth in population and the resultant pressure on land and water resources.

The FAO (1988) agroecological maps and reports, which cover the whole of Bangladesh, provide a reasonable overview of pre-Project environmental conditions, as they are derived from soil surveys carried out mainly between 1965 and 1977. In Zilkar Haor area, the relevant soil survey took place in 1976.

Zilkar Haor is a small area and pre-project it was agro-ecologically straightforward, with a simple pattern of beels in a lowlying basin surrounded by relatively much higher land to the west, south and especially extensive on the east. FAO (1988) included it in their Eastern Surma-Kusiyara Floodplain agroecological region (AER), within which no agroecological subregions (AES) are defined. Two soil associations are mapped by FAO in the Project Areas, correlating with the high land (Se 477) and basin (Se 480) respectively. Table N13 summarises the FAO classification within the Project Area.

The FAO agroecological classification, therefore, provides a broad spatial framework for environmental assessment both before and after the Project, especially when related to the pre-project flood depths given in Table N.13. In the Project area, however, the simple highland-basin pattern mapped by FAO had already been interrupted by the construction of the Gangina cross-bund, running roughly north-south between the Singar and Surma rivers. The aim of this was to pond back water in the higher Haparu Haor for release through cuts into Zilkar Haor during the dry season, where it was used for extensive Boro paddy irrigation.

One of the aims of the environmental fieldwork, therefore, was to refine the FAO classification and map further, to establish agroecological divisions (AED). The AED are units which relate directly to pre-project (and post-project) environmental conditions (Table N.13). They are mapped in Figure N.7 at the FAP 12 map scale here of 1:50,000.

Four AEDs have been defined and are schematically illustrated in Figure N.8. Pre-project conditions in each are discussed below.

AED A: Haparu High Land

AED A occupies much of the eastern half of the Project Area, covering about 40.5 per cent (2,150 ha.) of it. It consists mostly of Medium Highland, with a substantial proportion of Highland and settlements (most of which are also on Highland). Occasional undulations in the surface create slightly lower areas. Flooding ranged from negligible to moderate over most of the AED, which was afforded some protection in the south from the Surma River floods by the Sylhet-Sunamganj main road. In the north, flooding came from the Singar Khal (actually a sizeable river) and on the east the small Sadi Khal brought floods from both Surma and Singar.

Floods in the Project Area arrived as early flash floods in April-May and again more steadily as higher monsoon flooding in July-August. In addition, however, flooding was also

caused or exacerbated by the extremely high rainfall, especially during the monsoon but in some years (such as 1991) in earlier months also. Annual rainfall approaches 5,000 mm.

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

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

Table N13 Zilkar Haor: Agroecological Classification

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

AED B: Zilkar High Land

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

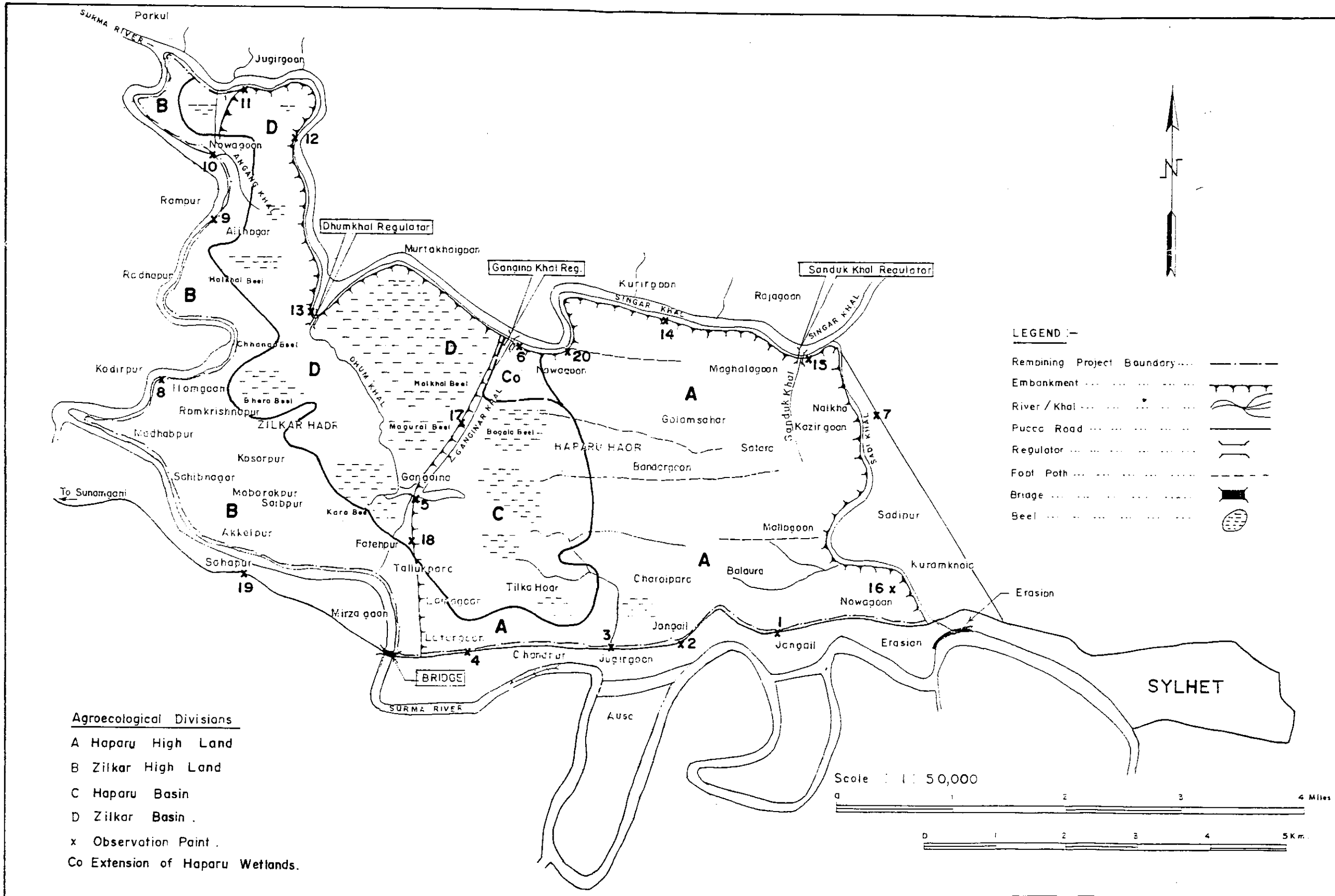
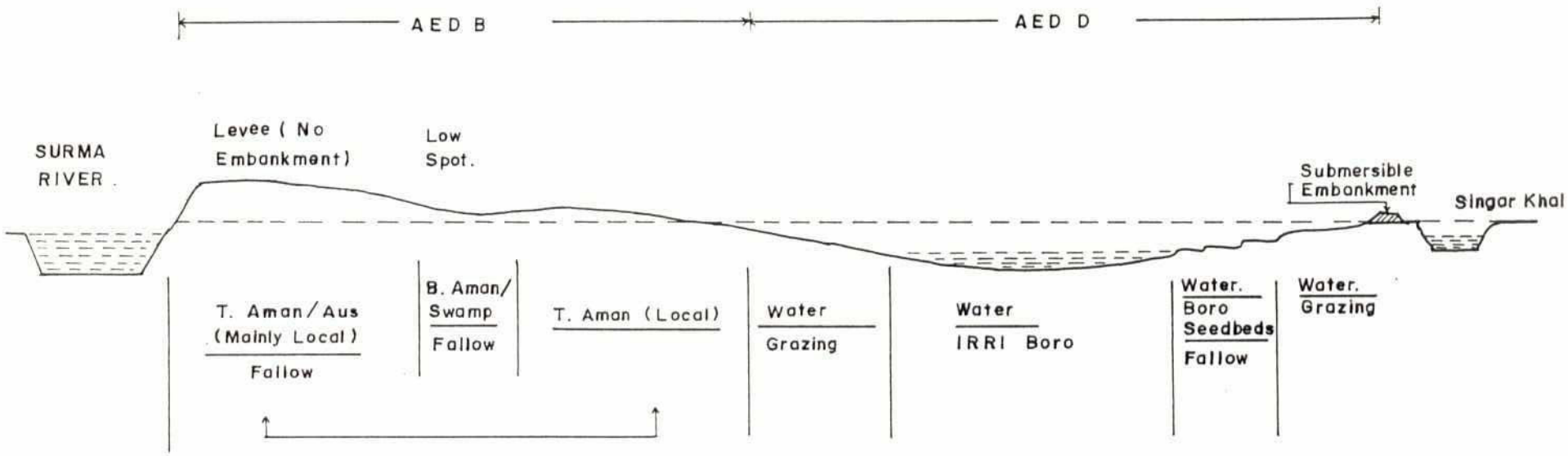


FIGURE : N7 AGROECOLOGICAL DIVISIONS AND OBSERVATION POINTS.

ZILKAR HAOR, SYLHET

FIGURE: N8

ZILKAR HAOR : AGROECOLOGICAL DIVISIONS (AED)



NOTE :-

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

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

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

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

AED C: Haparu Basin

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

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

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

AED D: Zilkar Basin

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

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

Land use was much the same as in AED C, but with even more emphasis on irrigated Boro resulting from the additional supplies of irrigation water. Fishing and grazing also seem

to have been more important than in AED C, due to a much greater extent of seasonal wetland and to deeper pools for fish.

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

N6.2 External Areas

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

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

The Surma is a large river, fairly incised in the landscape but still subject to overbank flooding in the wet season. As a result, there is a levee forming relatively high land, especially downstream of Mirzagaon road bridge. Below this, along the southern and western margins of Zilkar Haor, no embankment has been constructed and the levee serves this purpose. The Surma Riverine Area, therefore, only extends along the south side of Haparu Haor. Spoil heaps from two cuts across river loops and various other low local bunds complicate water movements within the URA, which is occupied by either cultivation or settlements. Very high floods overtop the road embankment to enter the Project Area. The setback of the road from the river is generally 300-400 metres and is occupied by either cultivation or settlements.

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

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

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

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

Table N.14 Physical Environmental Impacts.

Physical Issues	Degree of Environmental Impact								
	Project Area Impacts					External Impacts			
	A	B	C	D	Overall	URA	IRA	ARA	Overal l
WATER									
a. River Flow	-	-	-	-	-	0	0	01	0
b. River Quality	-	-	-	-	-	0	0	0	0
c. River Morphology	-	-	-	-	-	0	0	0	0
d. Flooding and Drainage	+2	0	0	+1	+2	-1	-1	-1	-1
e. Groundwater Levels/Recharge	0	0	0	0	0	0	0	0	0
f. Groundwater Quality	0	0	0	0	0	0	0	0	0
g. Wetland and Waterbodies Extent/Recharge	0	0	+1	0	0	0	0	0	0
h. Wetland and Waterbodies Quality	0	0	0	0	0	0	0	0	0
LAND									
a. Soil Fertility	0	0	0	0	0	0	0	0	0
b. Soil Physical Characteristics	0	0	0	0	0	0	0	0	0
c. Soil Moisture Status	+2	0	+2	+2	+2	-1	-1	-1	-1
d. Soil Erosion	-1	0	-1	-1	-1	0	0	0	0
e. Land Capability	+2	0	+1	+2	+2	-1	-1	-1	-1
f. Land Availability	0	0	-1	0	0	0	0	0	0

Table N.15 Biological Environmental Impacts

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

Table N.16 Human Environmental Impacts

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

N6.3 Conclusions

Conclusions can be summarised in terms of the main environmental impacts of the Zilkar Haor FCD/I Project on the Project Area and the external riverine areas. Environmental impacts have been assessed by environmental scoping and are presented in Tables N.14-N.16. The agroecological divisions (AED) are defined on Figure N.7 and in Table N.13.

N6.3.1 The Project Area

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

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

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

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

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

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

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

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

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

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

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

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

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

It is noticeable from Table N.16 that negative biotic impacts have been very limited. As in most of Bangladesh, ecological changes in the last few decades have been substantial in the Project Area. Such changes include the reduction in natural wetlands extent, accompanied by the marked decline in birds, fish and other wildlife. These had largely taken place in Zilkar Haor by 1983, when project construction started and would have continued

subsequently irrespective of the Project. In the last three years, fish disease has added a further marked negative trend, again apparently unrelated to the Project.

It is difficult to asses, therefore, the degree of additional impact when the Project's influence is superimposed upon these ongoing trends and the already dominantly anthropic landscape. Clearly, starting from such a biologically poor baseline as existed by 1983, biotic impacts are unlikely to be other than negligible or occasionally minor.

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

N6.3.2 External Impact Areas

Tables N.14-N.16 also show the generally minor physical and human impacts of the Project on the external riverine areas along the Surma and Singar rivers and the Sadi Khal. There have been negligible biotic impacts there. The Project is not considered to create significant cumulative downstream impacts because it is not part of any close group of similar FCD projects.

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

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

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

N7 PEP OF KOLABASHUKHALI PROJECT

The Barnal-Silimpur-Kolabashukhali FCD Project, referred to here for convenience as the Kolabashukhali Project, was constructed during 1979-1983. 1991 was therefore the Project's eighth monsoon season. In addition to flood control and drainage, the Project initially sought 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 the bibliography to this Appendix.

Kolabashukhali Project Area forms an island between tidal rivers of the lower Ganges system, immediately north of Khulna city, two-thirds of which 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 N.17 and Figures N.9 and N.10. Table N.17 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:

N7.1 Agroecological Divisions

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 3,500 ha of high urban land which is excluded from the Project Area as defined here. AED A as mapped (Figure N.9) accounts for only 9 per cent of the area.

Most of AED A consists of Soil Association Gh 815 (Table N.17) 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 N.10 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 (top soil) and 7.0 (subsoil) on the ridges and slightly lower in the basins.

Table N.17 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	Gi 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	

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

Source: FAO, 1988 and consultants

Pre-project land use was variable in AED A, reflecting the variations in flooding depth (Table N.17). 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 cultivation of 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 Katakhali and Chitra Rivers, covering about 23 per cent (5857 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 depressions 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.

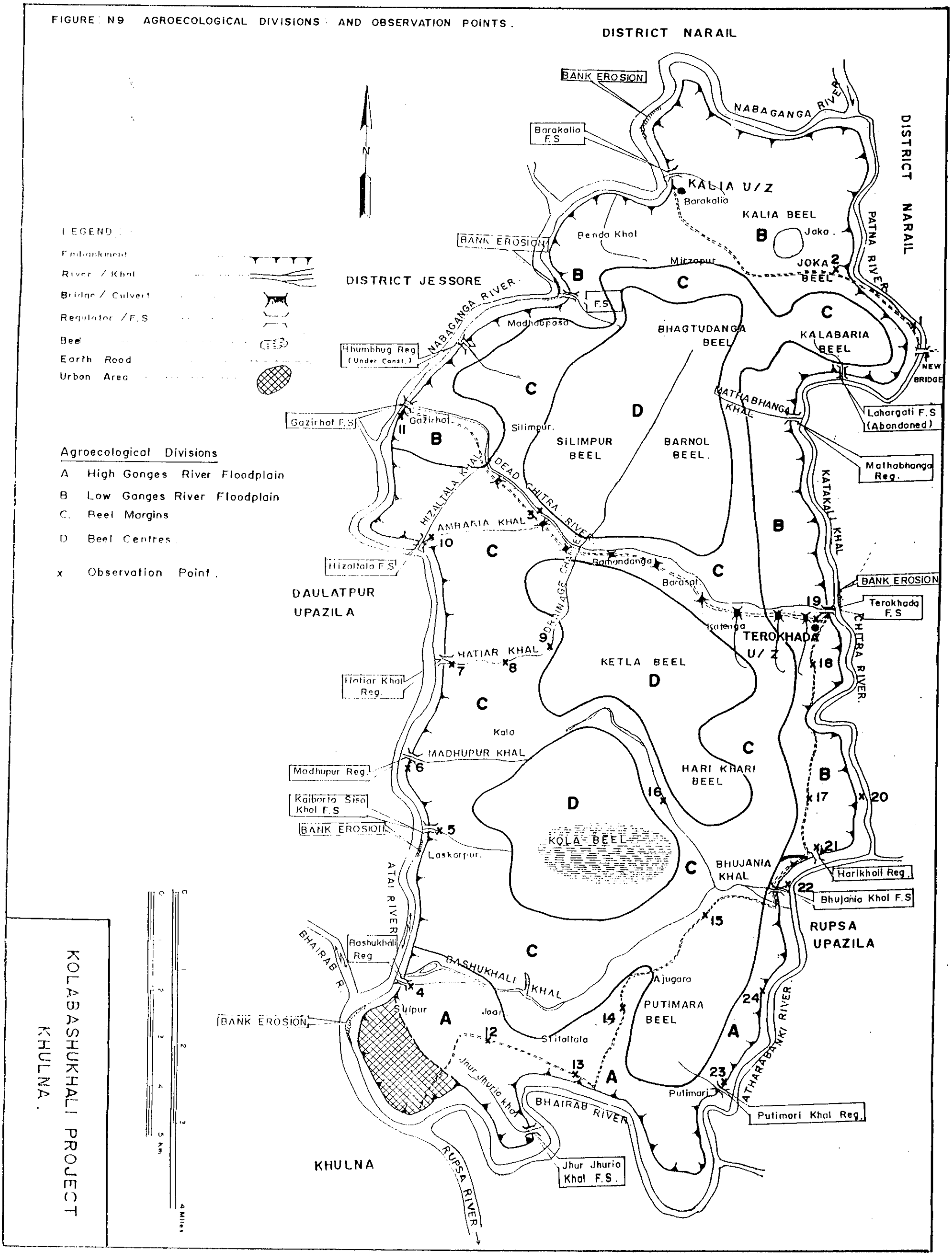
Flooding was consequently somewhat more pronounced in pre-project times, although the AED occupies a position further upstream of tidal water. AED B continued to receive adequately fresh water throughout most of the rabi season, and consequently had potential for irrigation.

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.

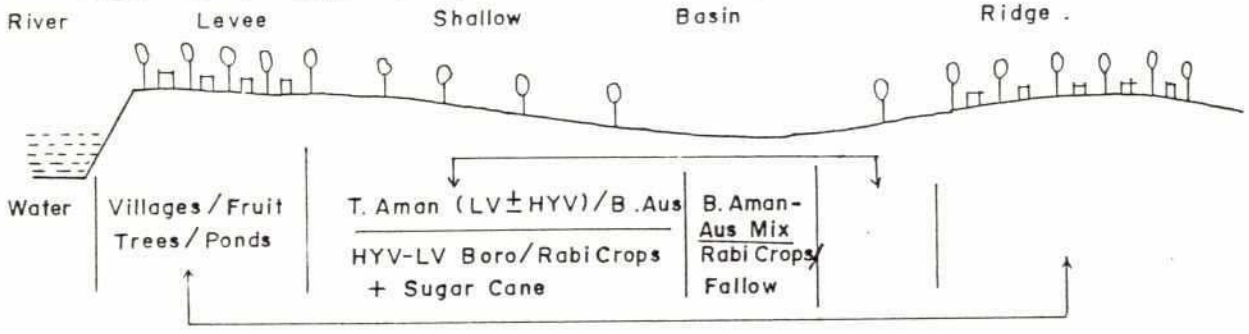
FIGURE : N9 AGROECOLOGICAL DIVISIONS AND OBSERVATION POINTS.



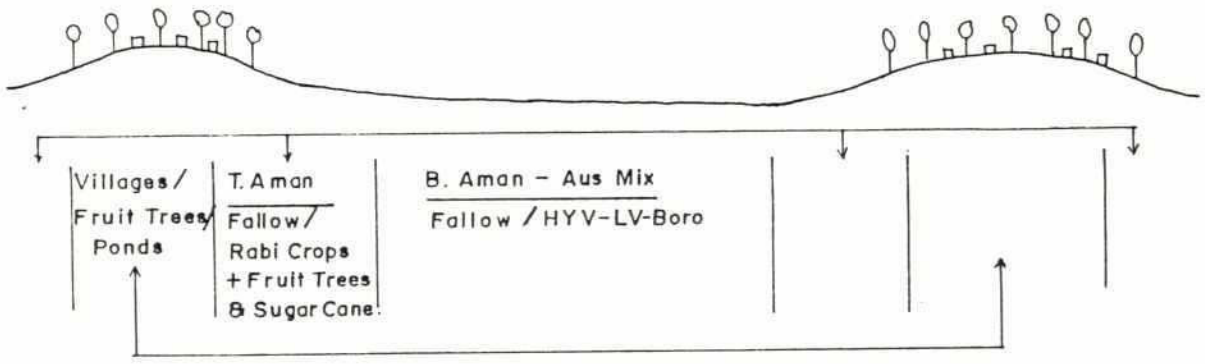
KOLABASHUKHALI PROJECT
KHULNA.

FIGURE : N 10 **KOLABASHUKHALI : AGROECOLOGICAL DIVISIONS (AED)**

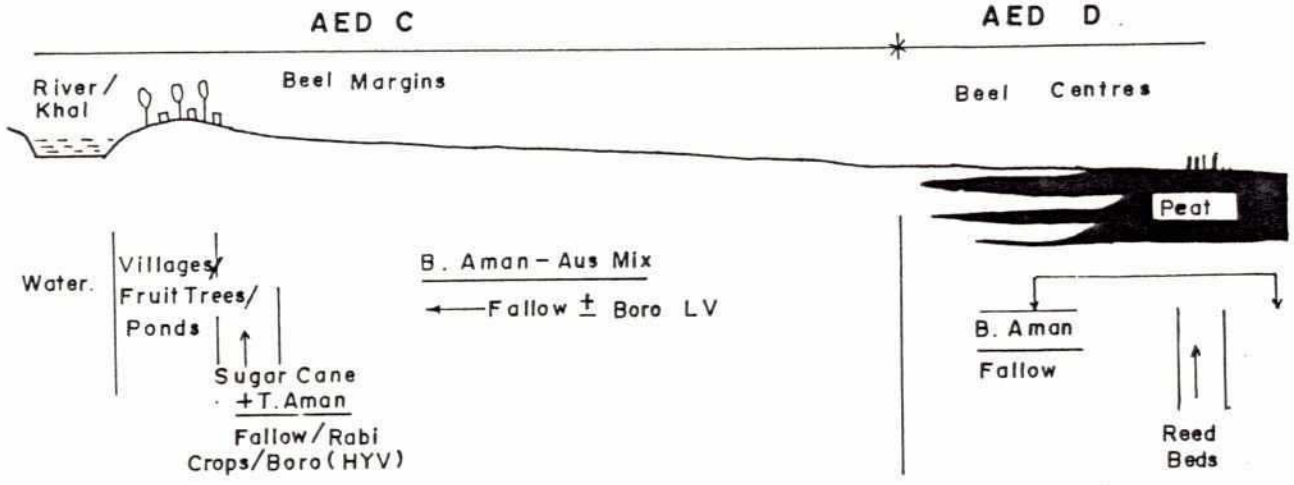
AED A : High Ganges River Floodplain



AED B : Low Ganges River Floodplain



AEDs C and D : Gopalganj — Khulna Beels.



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 (10314 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 tracks 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 attempts 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-Barnol Beels. They cover 27.5 per cent of the Project Area (about 7000 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 N.17) 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.

N7.2 External Areas

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 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, Katakuli 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 Typha vegetation. These reeds are systematically cut for roofing and walls. On the left banks most of the land forms the Control Area selected for the Kolabashukhali PIE, Buter 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.

N7.3 Environmental Screening

Environmental screening was based on a scoping exercise, described in the Kolabashukhali PIE report, to evaluate project activities in terms of their influence. The originally planned primary project activities were flood protection and drainage, accompanied a roads programme, agricultural support and some irrigation via the drainage 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 risks 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.

N7.4 Findings

Findings 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 10.4-10.6 and are presented in Tables N.18-N.20. The agroecological divisions (AED) provide a spatial distribution perspective on impacts. They are defined in Figure N.9 and Table N.17. 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.

Table N.18 Physical Environmental Impacts.

Physical Issues	Environmental Impact								
	Project Area Impacts (AEDs)					External Impacts			
	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	-1	-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	0+1	+2	+3	+3	-1	-10	0	-1
d. Soil Erosion	0	0	0	-1	-1	0	0	0	0
e. Soil Salinity	+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: FAP 12

Table N.19 Biological Environmental Issues

Biological Issues	Environmental Impact								
	Project Area Impacts (AEDs)					External Impacts			
	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

Source: FAP 12

Table N.20 Human Environmental Issues

Human Issues	Environmental Impact								
	Project Area Impacts (AEDs)					External Impacts			
	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	+1	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	+1	+1	+1	0	0	-2	-2	0	-2
i. Domestic Water Supply	0	0	-1	0	0	0	0	0	0
j. Sanitation	0	0	0	0	0	0	0	0	0
k. Recreation	0	0	0	0	0	0	0	+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	0	0	0	0	0	0	0	0	0
h. Equity	-1	-1	-1	-3	-2	-2	-2	0	-2
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	+1	-1	-1	+1?	0

Note: ? Uncertain impact.

N7.4.1 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 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. a corresponding rise in human carrying capacity;

v. a general appreciation of project benefits by people throughout the Project Area;

vi. a substantial improvement in the key socio-economic benefits of incomes, employment, land values and credit availability, with AED C gaining most;

vii. 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 these 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 terms, capture fisheries and fishermen 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 have by the likely acidification of drained peaty soils;

ii. decline in bird communities and habitats, particularly with references 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 in its initial years;

vii. cultural community has suffered, again due to the demise of the largely Hindu traditional fishing communities as social entities.

It is noticeable from Table N.20 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 manifestation of which was the limited and generally sustainable exploitation of the peat beels (AED D) pre-Project.

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.

N7.4.2 External Impact Areas

Tables N.18-N.20 also show the Project's environmental impacts on the three external impact areas: the western riverine area (WRA); the eastern riverine area and Buter 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 in respect of off-site impacts that it is the combined 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 Buter 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 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 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 seem 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.

APPENDIX O

ECONOMIC IMPACT

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APPENDIX O

ECONOMIC IMPACT

O1 INTRODUCTION

O1.1 Approach to Evaluation

Economic evaluation of FCD Projects centres around the identification of cost and benefit streams resulting from project impact, which are then compared with the "without project" situation. In Bangladesh, most analysts have to fall back on the "control" method normally associated with the natural sciences. This is necessitated by the general absence of bench-mark data on pre-project conditions, while the recall method is not considered suitable for projects initiated many years ago.

The use of the control method is not without its problems. Numerous FCD investments all over the country have made it very difficult to locate areas similar to pre-project conditions. Even where reasonable control areas can be identified, particular care needs to be taken so that autonomous changes are not attributed to the Project.

O1.2 Projects Evaluated

A total of seventeen projects were evaluated under the FAP 12 Agricultural Study. Out of these, 5 were evaluated using the orthodox, control area dependant methodology, while the remaining twelve were the subject of rapid rural appraisals (RRAs). The latter depended heavily on recall to form an impression of pre-project conditions for comparison with the post-project situation, assessed independently, on the basis of field interviews. This technical note describes the detailed procedure used in the economic analyses undertaken to arrive at estimates of EIRR and NPV, and concludes by a presentation of findings.

O1.3 Measures of Economic Performance

The projects were assessed in terms of the Economic Internal Rate of Return (EIRR), Benefit-Cost Ratio (BCR) and Net Present Value (NPV). The assumed opportunity cost of capital was taken to be 12 per cent, in line with FPCO(1991), and this value was therefore used as the threshold EIRR for economic viability and as the discount rate for calculating BCR and NPV.

O2 ECONOMIC PERFORMANCE ESTIMATES FROM THE RRAS

RRA methodology can provide agricultural benefit data for a first approximation to re-estimated measures of economic performance. In some cases, however, re-estimation was severely hampered by lack of cost data, since project documentation was missing. While the RRA estimates of economic performance are therefore necessarily only approximate, they display sufficient consistency between themselves (and with the PIEs, in the two cases where comparison is possible) for FAP 12 to believe they provide a valid guide to project performance. The estimates of EIRR from the RRAs are presented in Table O1.

O2.1 Project Costs

Project costs for the RRAs were usually based on BWDB sources. While attempts were made to obtain actual cost data, this was frequently not possible within the time available , so that it was necessary to fall back on the pre-project cost estimates given in the Project Proformas (PPs). All costs, including capital, O&M and rehabilitation costs, were converted to 1991 values, using the construction cost index (general) available from the Bangladesh Bureau of Statistics (BBS 1991). To convert to economic values, conversion factors for shadow pricing supplied by FPCO (1991) were used. However, since the available cost data were generally not sufficiently disaggregated to directly apply the FPCO conversion factors, project structure costs were further decomposed using standard BWDB ratios.

O2.2 Benefits

Gross benefits were estimated from RRA field data on cropping patterns, yields and volume of by products for the "before" and "after" situations, using area data from the PP to extrapolate changes to the entire project area. In general only incremental paddy outputs were estimated. Care has to be taken to ensure that autonomous changes are not ascribed to the project being investigated, in particular changes brought about by minor irrigation development leading to expansion in HYV Boro. Incremental outputs were converted to finalised values using current (post-harvest, 1991) prices, and to economic values by using conversion factors available from FPCO (1991).

O2.3 Costs of Production

To arrive at net incremental returns, it is necessary to estimate net returns for the pre- and post-situations, which essentially means deducting costs of production from gross returns. The RRA generated per hectare input costs for different paddy crops, which were converted to economic values. Given the cropping patterns, average per hectare costs were estimated and then extrapolated using total project hectarage.

The greatest drawback to estimation of net incremental benefits using RRA data is the assumption that the yield and cost data based on a limited number of observations, would be sufficiently close to the true figures. In addition for older projects, the recall tends to become even less reliable for gauging pre-project yields and costs.

O2.4 Non-Agricultural Impacts

While in most cases, evaluation of FCD projects centres around the agricultural impact generated, other impacts may also be sufficiently significant to warrant inclusion in the benefit and cost streams. In particular, the impact on fisheries and navigation could be sufficiently severe to warrant attention; an attempt was made to cost the former in all RRAs where it was relevant. Although in the RRAs it was not always possible to quantify these types of impacts, attempts were made to indicate directions of change and broad orders of magnitude. Fish losses were paricularly severe in Polder 17/2, BRE (both Kamarjani and Kazipur) and Sakunia Beel, causing net benefits to be seriously affected, and in the case of Polder 17/2, even changing the EIRR from positive to negative.

O2.5 Results

Out of the 12 RRAs attempted, an acceptable range of EIRR was found for 6 projects. These EIRRs ranged from 30 per cent (Katakhali Khal) to 96 per cent (Kahua Muhuri). As far as the non-viable projects are concerned, generalisations are difficult.

In one case, the project suffered because of a failure to recognise the cumulative effect of overall river basin developments (Nagor River), while high capital cost combined with very adverse effects on fisheries made Polder 17/2 non-viable. On the strength of agricultural benefits alone, Sakunia Beel may have performed better, but the large fishery losses have rendered the project non-viable. Silimpur-Karatia however, suffers from poor project concept, while BRE is subject to acute erosion and the frequent need for rehabilitation works.

The six successful projects appear to share certain broad characteristics. The projects are small in terms of the command area, and capital costs per hectare are low (five with a capital cost of Tk 7500 per hectare or less) and the period of implementation is short (less than four years). It may be mentioned however, that small is not necessarily beautiful, as seen from the experience of the six non-viable projects.

O3 ECONOMIC PERFORMANCE ESTIMATES FROM THE PIES

Full project impact evaluations (PIEs) were carried out on five projects, four of which were large, with net benefited areas ranging from just over 14000 ha (MDIP) to 50000 ha (Kurigram South). Zilkar Haor, the fifth PIE, was chosen as an example of a small (4000 ha), quick yielding, submersible embankment project.

The objective of the PIEs was to quantify impacts and be able to attach confidence levels to the size of impacts estimated. It is of critical importance for evaluation of this nature to be able to identify reasonable control areas, particularly in the absence of bench mark data. Reasonable controls were identified, although it became clear that this will be increasingly difficult in the future due to the proliferation of FCD projects and the disappearance of "unprotected" areas.

Essentially, the EIRRs estimated for the PIEs took into account the benefits and disbenefits arising from the impact on agriculture and fisheries. Other impacts, particularly on navigation or the environment (both natural and human) were not incorporated into the analyses.

O3.1 Project Costs

For the PIEs greater effort was made to locate actual project costs, both for capital and O&M. This was particularly important for the latter as it tends to diverge considerably from the estimates available from the PP. Fortunately, for all the 5 PIE projects, actual O&M costs were made available. For two projects, capital costs shown in the PP had to be used (Kurigram South, Chalan Beel), instead of actual costs.

Rehabilitation works arising out of the severe floods in 1987 and 1988, were assumed to be rare events, not likely to recur during the remaining project life. Relaxing this assumption would of course reduce the estimated economic performance of the projects.

As for the RRAs, all costs were converted to 1991 prices and FPCO conversion factors were applied to obtain economic values. Unlike the RRA exercises, no general inflation index like the Construction Cost Index (CCI) was used to adjust to 1991 prices. The specific index used depended on the type of cost involved. Thus for buildings, regulators, sluice gates, etc. the CC I was used, while for predominantly labour-intensive structures (for example earthwork), the agricultural wage rate index was used. For foreign exchange costs, the IBRD MUV index was used.

As for the RRAs, project components were broken down further to basic materials and labour using standard BWDB ratios, to facilitate shadow pricing.

O3.2 Project Benefits

Benefits and disbenefits arising from the impacts on agriculture and fisheries respectively, were estimated. Agricultural impact was assessed on the basis of comparisons with the control area. For outputs, harvest prices were used. Net economic and financial incremental returns were calculated on a per hectare basis, and then extrapolated using the command area and cropping intensity. The methodology for estimation of fishery losses is given in Appendix J, Volume 3 of the FAP 12 Draft Final Report.

The project life was assumed to be 30 years from date of completion. Phasing of benefits in the initial years of the project has a significant impact on the economic analysis, and was based on local interviews with beneficiaries and BWDB officials. When no other information was available, the assumption of a linear build up of benefits given in the FPCO (1991) guidelines was used.

O3.3 Non-Agricultural Impacts

The post-evaluations have not included some impacts which are potentially open to economic evaluation, such as reduction of flood damage to infrastructure and property, communication and secondary effects. These would tend to raise benefits, probably by a small margin. Nor could the post-evaluations give any weight to the non-quantifiable variables that may be important, such as environmental parameters, greater psychological security, and creation of social tensions, all of which have a bearing on net benefits. It needs to be noted however, that it is the larger projects which tend to be associated with negative environmental effects and greater social tensions, arising for example, from public cuts.

O3.4 Results

The PIE results and basic data are presented in Table O1 and Figures O1 and O2. Three projects were found to be viable on the basis of the estimated EIRR (higher than 12 per cent). The EIRR for Zilkar Haor, a small FCD/I type project with a submersible sub-component, was 40 per cent. The other two viable projects are large, with Kurigram South at 50000 ha and KBK at 18000 ha. Kurigram shows an EIRR of 22 per cent, and KBK one of 25 per cent. The EIRR for Kurigram, however, is very sensitive to estimates of crop yields; a 5 per cent decrease in average paddy yields in the project area, combined with a similar increase in the control area, drives the NPV to below zero. These variations are well within the confidence limits for estimated yields at Kurigram. This level of sensitivity is not unexpected, given the relatively low cost per hectare of most FCD projects, which means that small incremental gains in output can cause drastic changes in the cost:benefit ratio.

The other two PIE projects show much poorer performance. Chalan Beel D has an EIRR of 15 per cent under a low estimate of fishery losses, and 9 per cent under a high estimate, but there is reason to believe that even these may over-estimate the project's true performance. There is no significant difference in yields between the impacted and control areas, the apparent superiority of the impacted area being based on higher net returns to cropping, but this is likely to be an effect of the particular survey year. The poor performance of Chalan Beel D seems to be due to its ineffectiveness in encouraging a move to higher-yielding varieties and greater input use, and this in turn is due to the perennial problem of public cuts which nulifies the greater agricultural security the project was intended to provide.

The poor performance of MDIP results from quite different causes. The impacted area shows a large and highly significant superiority of yield and intensity over the control, but the consequent very large gain in output is insufficient to cover the extraordinarily high capital and O&M costs of the project. The project has suffered from a series of problems during and immediately after implementation, but sensitivity analyses show that removing these would not make the project viable. The original decision to proceed with the project seems to have been based on unrealistic estimates of the achievable benefits, without-project yields estimated by both FAP 12 and CIRDAP surveys being nearly double those assumed for the feasibility study.

O4 CONCLUSIONS

Taking both the RRA and PIE results together, certain broad conclusions emerge quite clearly.

i. A short implementation period (4 years or less) is a necessary, but not a sufficient, condition for achievement of a high EIRR (Figure O1). A short implementation period will not, of course, save a project which is seriously unsound in its basic concept, as is shown by Silimpur-Karatia, and even more clearly by Nagor River.

ii. Projects with a high EIRR (25 to 96 per cent) are generally small, conceptually simple projects (Halir Haor, Zilkar Haor, Kahua Muhuri), with the net benefited area in the range of around 2000 ha to 7000 ha (Figure O2). The most striking exception is Kolabashukhali, which is a 'large' project (net benefited area exceeds 18000 ha), but which has nevertheless performed well (EIRR of around 24 per cent); this is probably because KBK, though large, is a simple project, and was completed on time and to original cost estimates. The EIRR for Kurigram is quite respectable, although the results are very sensitive to small changes in yields. Chalan Beel has similarities with Kurigram, but appears to lie in an even greyer area, with considerable variation in the point estimate of the EIRR under different assumptions on fishery losses.

iii. Capital costs per hectare are small (compared to international standards) and with one exception do not seem to vary greatly from project to project (Figure O3). The exception is the Meghna-Dhonagoda Irrigation Project, where costs have been extraordinarily high, so that even the very high benefits failed to yield an acceptable EIRR. Generally costs per hectare ranged from Tk 3000 to Tk 18000.

iv. For projects conforming to the generally unambitious technology of FCDI projects in Bangladesh, there is a strong relationship between EIRR and net benefits to agriculture and fisheries (Figure O4); in other words, variation in capital and O&M costs has relatively little impact on performance. The exception is Meghna-Dhonagoda, where although the net benefits are the highest of any project studied, the project is non-viable due to the combination of extraordinarily high construction and O&M costs, combined with a long implementation period.

v. O&M costs have tended to remain in the range of Tk 150-400 per hectare, although in MDIP, which depends on expensive pumping, they are over Tk 2400. As a proportion of capital costs this averages around 3 to 5 per cent; a figure which is higher than generally assumed in feasibility studies.

vi. Fisheries losses have tended to reduce benefits quite significantly, but were in most cases were not high enough to destroy project viability. The glaring exceptions are Polder 17/2 and Chalan Beel D, and to a lesser extent Sakunia Beel. Fishery losses have ranged from negligible to Tk 8500 per hectare, but normally hovered around Tk 1000/ha..

For two of the PIE projects (MDIP and KBK), EIRR estimates based on the RRAs, was available and were found to be comparable to the PIE generated estimates. Thus the RRAs produced an EIRR of 5 and 17 per cent for MDIP and KBK, while the PIE estimates were 6.7 and 25 per cent.

Table O1 **Financial and Economic Performance of Projects**
(1991 prices)

Project	Net Benefited Area (NBA) (ha)	Capital Cost/ha (NBA) (Tk)	O&M Cost Cost/ha (NBA) (Tk)	O&M Cost/ha (% of capital cost/ha)	Annual Ag. Bens per ha (NBA) (Tk)	Annual Fishery loss/ha (NBA) (Tk)	Ag+Fish Benefits per ha (NBA) (Tk)	Estimated Economic IRR (%)	Implement-ation period (years)
Kahua Muhuri	2024	11512	235	2.0	12352	208	12143	96	1
Sonamukhi-Banmander	7400	6284	314	5.0	10514	0	10514	65	3
Halir Haor	6686	3671	191	5.2	2372	0	2372	65	1
Konapara Embankment	3116	2634	132	5.0	12095	1161	10934	62	3
Protappur IP	4000	3419	224	6.5	5686	0	5686	54	4
Zilkar Haor (PIE)	4238	17810	333	1.9	3964	n.a.	3964	40	3
Katakhali Khal	2520	7548	0	0.0	3925	1202	2722	30	3
KBK (PIE)	18623	12041	624	5.2	4360	1020	3340	25	7
Kurigram South (PIE)	50000	13672	776	5.7	5610	80	5530	22	10
Silimpur - Karatia	1012	10829	0	0.0	956	n.a.	956	10	1
Sakunia Beel	4400	4787	28	0.6	1023	439	584	10	4
Chalan Beel Polder D	37235	9196	129	1.4	2402	1488	914	9	8
MDIP (PIE)	14367	129205	2417	1.9	14130	693	13437	7	12
BRE Kamarjani	8783	6619	340	5.1	1547	922	625	3	10
BRE Kazipur	8788	5461	280	5.1	1500	1075	424	0	10
Nagor River	9312	7962	n.a.	n.a.	-1074	n.a.	-1074	-10	2
Polder 17/2	2792	15136	440	2.9	6229	8453	-2224	-10	13

Source: RRA and PIE surveys 1991

Notes: Some figures are very rough estimates and should be treated with caution.
Some figures in original RRA reports have been corrected.

Figure O1 EIRR and Implementation Period
(negative EIRRS indicative only)

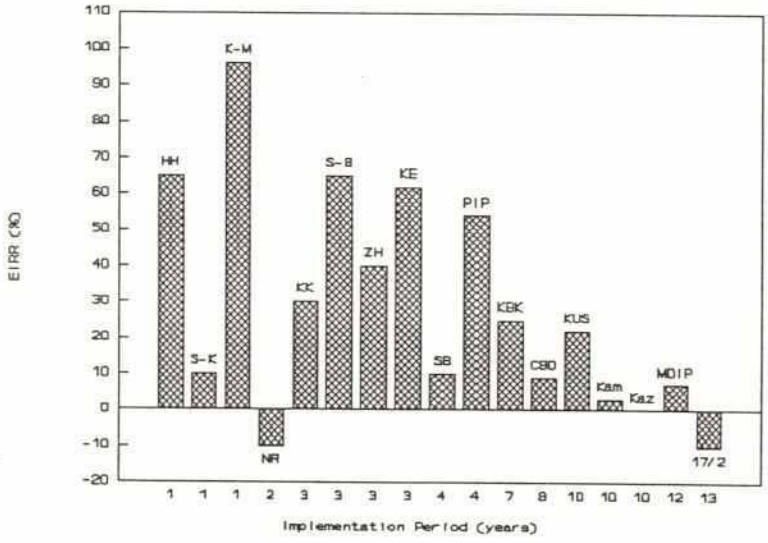
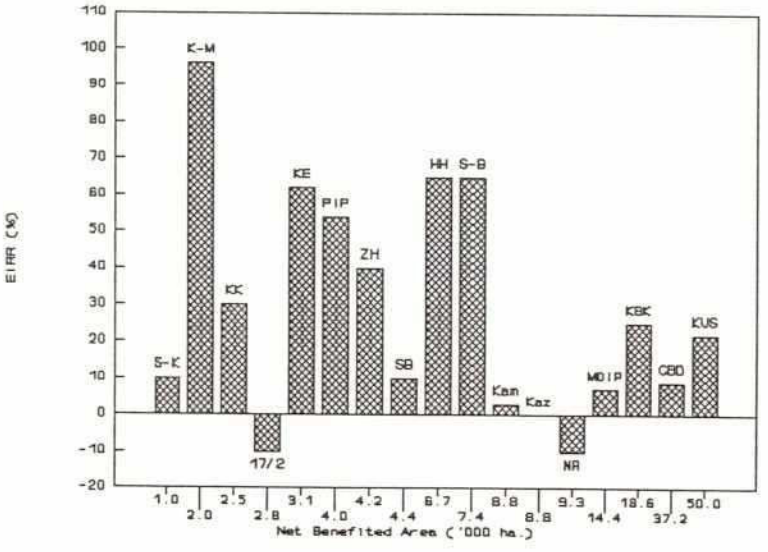


Figure O2 EIRR and Net Benefited Area
(negative EIRRS indicative only)



Key to Projects:

17/2	Polder 17/2	KK	Katakhali Khal	SB	Sakunia Beel
CBD	Chalan Beel Polder D	K-M	Kahua-Muhuri	S-K	Silimpur-Karatia
HH	Halir Haor	KUS	Kurigram South	ZH	Zilkar Haor
Kam	BRE Kamarjani Reach	MDIP	Meghna-Dhonagoda		
Kaz	BRE Kazipur Reach	NR	Nagor River		
KBK	Kolabashukhali	PIP	Protappur		
KE	Konapara Embankment	S-B	Sonamukhi-Banmander		

Figure O3 EIRR and Capital Cost

(negative EIRRS indicative only)

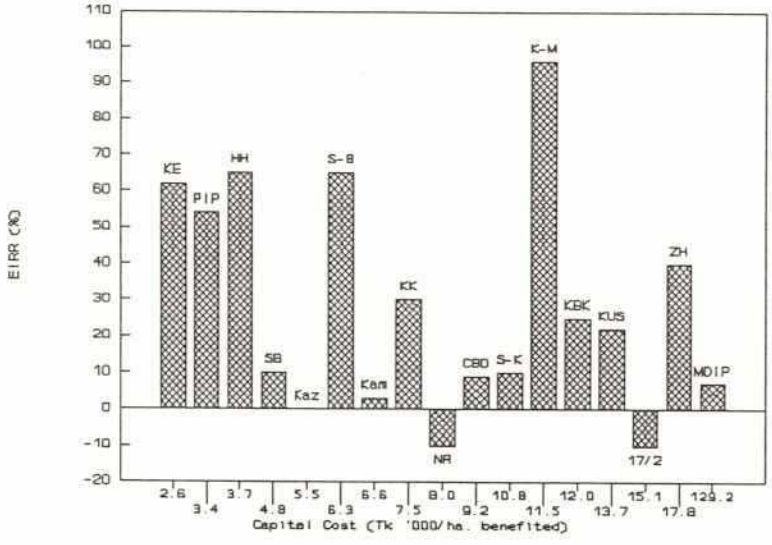
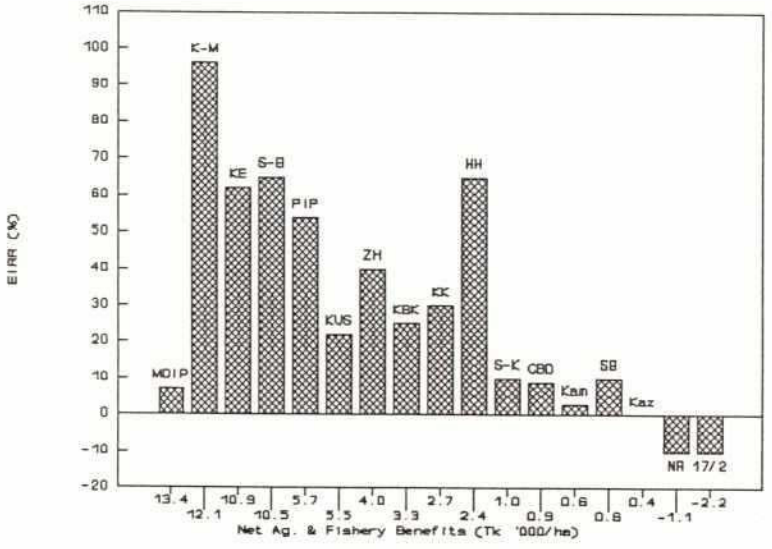


Figure O4 EIRR and Net Agricultural and Fishery Benefits

(negative EIRRs indicative only)



Key to Projects:

17/2	Polder 17/2	KK	Katakhali Khal	SB	Sakunia Beel
CBD	Chalan Beel Polder D	K-M	Kahua-Muhuri	S-K	Silimpur-Karatia
HH	Halir Haor	KUS	Kurigram South	ZH	Zilkar Haor
Kam	BRE Kamarjani Reach	MDIP	Meghna-Dhonagoda		
Kaz	BRE Kazipur Reach	NR	Nagor River		
KBK	Kolabashukhali	PIP	Protappur		
KE	Konapara Embankment	S-B	Sonamukhi-Banmander		

APPENDIX P

VARIANCE CALCULATIONS FOR 2-STAGE PPS/SRS SAMPLE

APPENDIX P

VARIANCE CALCULATIONS FOR 2-STAGE PPS/SRS SAMPLE

As described in the FAP 12 Methodology Report, the PIE surveys used a two-stage sample design, in order to avoid the need for compiling final-stage sample frames covering the entire population in each project. The first-stage sample units, which were the mouzas (revenue villages) were selected with probability proportional to size (PPS) and the second (final) stage sample units, which were either cultivating or labour households, were selected by simple random sampling (SRS) within the selected first-stage units.

The variance algorithms supplied as standard with proprietary statistical analysis packages assume a single-stage simple random sample (SSRS) design. As such, they are not appropriate for a two-stage design, where it is necessary to take account of the relative contributions to the variance arising from variation within, and variation between, the first-stage sample units.

The variance algorithms used are given in equations 2, 4 and 6 below. They are derived from Cochrane (1983), Section 11.8, and are given in their present form in Poate and Daplyn (1990), Appendix 1.

For calculating variances using these algorithms, it is necessary to obtain the subtotals of the variable(s) being analysed, for the first-stage sample units. These subtotals are indicated by

Σy_{ij} and Σx_{ij}

in equations 2, 4 and 6. Since the number of first-stage units is quite small, it was found easiest to operationalise the variance algorithms by extracting the relevant sub-totals for the first-stage units using SPSS or dBase, and then to enter them into a Lotus 1-2-3 spreadsheet for variance calculation. Actual re-entry of the subtotals (which involves the risk of keypunching error) can be avoided if they are produced as an ASCII file which can be imported into Lotus.

APPENDIX P
STATISTICS FOR 2-STAGE PPS/SRS SAMPLE

EQUATION 1: POPULATION TOTAL OF A VARIABLE

$$Y = \frac{H}{mn} \sum_{n}^{i=1} \sum_{m}^{j=1} y_{ij}$$

EQUATION 2: VARIANCE OF TOTAL

$$\text{var}(Y) = \frac{H^2}{n(n-1)m^2} \left(\sum_{n}^{i=1} \left(\sum_{m}^{j=1} y_{ij} \right)^2 - \frac{1}{n} \left(\sum_{n}^{i=1} \sum_{m}^{j=1} y_{ij} \right)^2 \right)$$

Definitions of variables:

Variable	Definition	Value/Source
Y	Estimated pop. total for numerator	Computed - Eq. 1
X	Estimated pop. total for denominator	Computed - Eq. 1
H	Total households in sampled population	Derived from non-survey data
n	No. of clusters in sample	≤ 24 for Impacted, 12 for Control
m	Cluster size	5 for cultivator sample, 2 for labourers
y_{ij}	Value of y for j^{th} h'hold of i^{th} cluster	Original household data
x_{ij}	Value of x for j^{th} h'hold of i^{th} cluster	Original household data

APPENDIX P
STATISTICS FOR 2-STAGE PPS/SRS SAMPLE

EQUATION 3: POPULATION MEAN OF A VARIABLE

$$\bar{Y} = \frac{Y}{H}$$

EQUATION 4: VARIANCE OF MEAN

$$\text{var}(\bar{Y}) = \frac{1}{n(n-1)m^2} \left(\sum_{n}^{i=1} \left(\sum_{m}^{j=1} y_{ij} \right)^2 - \frac{1}{n} \left(\sum_{n}^{i=1} \sum_{m}^{j=1} y_{ij} \right)^2 \right)$$

Definitions of variables and sources:

Variable	Definition	Value/Source
Y	Estimated pop. total for numerator	Computed - Eq. 1
X	Estimated pop. total for denominator	Computed - Eq. 1
H	Total households in sampled population	Derived from non-survey data
n	No. of clusters in sample	≤ 24 for Impacted, 12 for Control
m	Cluster size	5 for cultivator sample, 2 for labourers
y_{ij}	Value of y for j^{th} h'hold of i^{th} cluster	Original household data
x_{ij}	Value of x for j^{th} h'hold of i^{th} cluster	Original household data
$\bar{Y}$	Estimated mean per household of Y	Computed - Eq. 3

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STATISTICS FOR 2-STAGE PPS/SRS SAMPLE

EQUATION 5: RATIO OF 2 VARIABLES

$$R = \frac{Y}{X}$$

EQUATION 6: VARIANCE OF RATIO

$$\text{var}(R) = \frac{H^2}{n(n-1)m^2X^2}\left[\sum_{n}^{i=1}\left(\sum_{m}^{j=1} y_{ij}\right)^2 + R^2\sum_{n}^{i=1}\left(\sum_{m}^{j=1} x_{ij}\right)^2 - 2R\sum_{n}^{i=1}\left(\sum_{m}^{j=1} y_{ij}\right)\left(\sum_{m}^{j=1} x_{ij}\right)\right]$$

Definitions of variables and sources:

Variable	Definition	Value/Source
Y	Estimated pop. total for numerator	Computed - Eq. 1
X	Estimated pop. total for denominator	Computed - Eq. 1
H	Total households in sampled population	Derived from non-survey data
n	No. of clusters in sample	≤ 24 for Impacted, 12 for Control
m	Cluster size	5 for cultivator sample, 2 for labourers
y_{ij}	Value of y for j^{th} h'hold of i^{th} cluster	Original household data
x_{ij}	Value of x for j^{th} h'hold of i^{th} cluster	Original household data
R	Estimated ratio of pop. totals Y/X	Computed - Eq. 5

REFERENCES

Cochrane, W. 1983 *Sampling Techniques*, John Wiley, New York, 1983.

Poate, C.D., & Daplyn, P.F. 1990 *Data for Agrarian Development*, Wye College, London University, 1990.