Government of the People's Republic of Bangladesh

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

BANGLADESH FLOOD ACTION PLAN

FAP 12
FCD/I AGRICULTURAL STUDY

FINAL REPORT

VOLUME 1
Main Report

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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

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

SUMMARY

S1 INTRODUCTION

The objectives of the Flood Action Plan FCD/I Agricultural Study, FAP 12, are to:

- assess the agricultural, economic, social and environmental impacts of FCD and FCDI projects and the extent to which technical and other objectives have been achieved;

- identify constraints to effective project management and recommend ways in which project design, operation and maintenance can be improved to increase overall production;

- develop guidelines and criteria to be used in the planning, design, implementation, operation and maintenance of projects under the Flood Action Plan.

The present report is the Final Report on the study. It includes summaries of the results of all the detailed project evaluations (in Volume 2) and detailed technical overviews of project impact by discipline (in Volumes 3 and 4). This main report (Volume 1) presents an overview of the study methodology, of the main conclusions on the impact of FCD/I projects, and of the FAP 12 recommendations and guidelines for future planning, design, operation and maintenance of FCD/I interventions.

S2 METHODOLOGY

S2.1 Previous Evaluations of FCD/I Projects

Over sixty completed FCD/I projects in Bangladesh have been evaluated over the past twenty years. Fiftee of these have been evaluated by two or more separate agencies. The evaluations vary greatly in quality and in methodological rigour. They provide a substantial base of background data on the impact of a broad range of FCD/I activities, and the FAP 12 team have used their results and, bearing their strengths and weaknesses in mind, discussed and compared their conclusions with FAP 12's own results.

S2.2 Selection of Projects for FAP 12 Evaluations

The selection of projects for evaluation was implemented in close liaison with the Flood Plan Coordination Organisation (FPCO) and Regional FAP Study teams. Twelve projects were selected for evaluation using Rapid Rural Appraisal (RRA) techniques only, and five for more detailed Project Impact Evaluations (PIE), following preliminary Rapid Rural Appraisals.

The project selection process took account of the following requirements:

- the regional distribution of projects had to reflect the relative importance of FCD/I interventions, by type and by area, in the different FAP Regions;

- however, polders in the coastal cyclone zone were excluded as they were being studied by FAP 7, the Cyclone Protection Project;

- FCD/I projects vary enormously in scale (from less than 1000 ha. to over 50000 ha.) and project selection should reflect this range;

- projects selected should have been completed by 1988, at the latest (so that impacts should be evident) but not before 1975 (to avoid problems associated with lengthy recall of pre-project conditions);

- preference should be given to projects which had not been the subject of a previous detailed post-evaluation;

- projects selected for PIE should be larger in area, and should offer potential control areas.

Key features of the seventeen selected projects are presented in Table S1, and their locations are shown on Figure S1. Between them the projects represent all the types of FCD/I interventions in Bangladesh, and can be expected to display much of the diversity present.

S2.3 Rapid Rural Appraisals

Rapid Rural Appraisals (RRAs) aim to provide a cost-effective means of data collection in a relatively short time-span, while avoiding some of the biases that often distort the results of "quick and dirty" information collection.

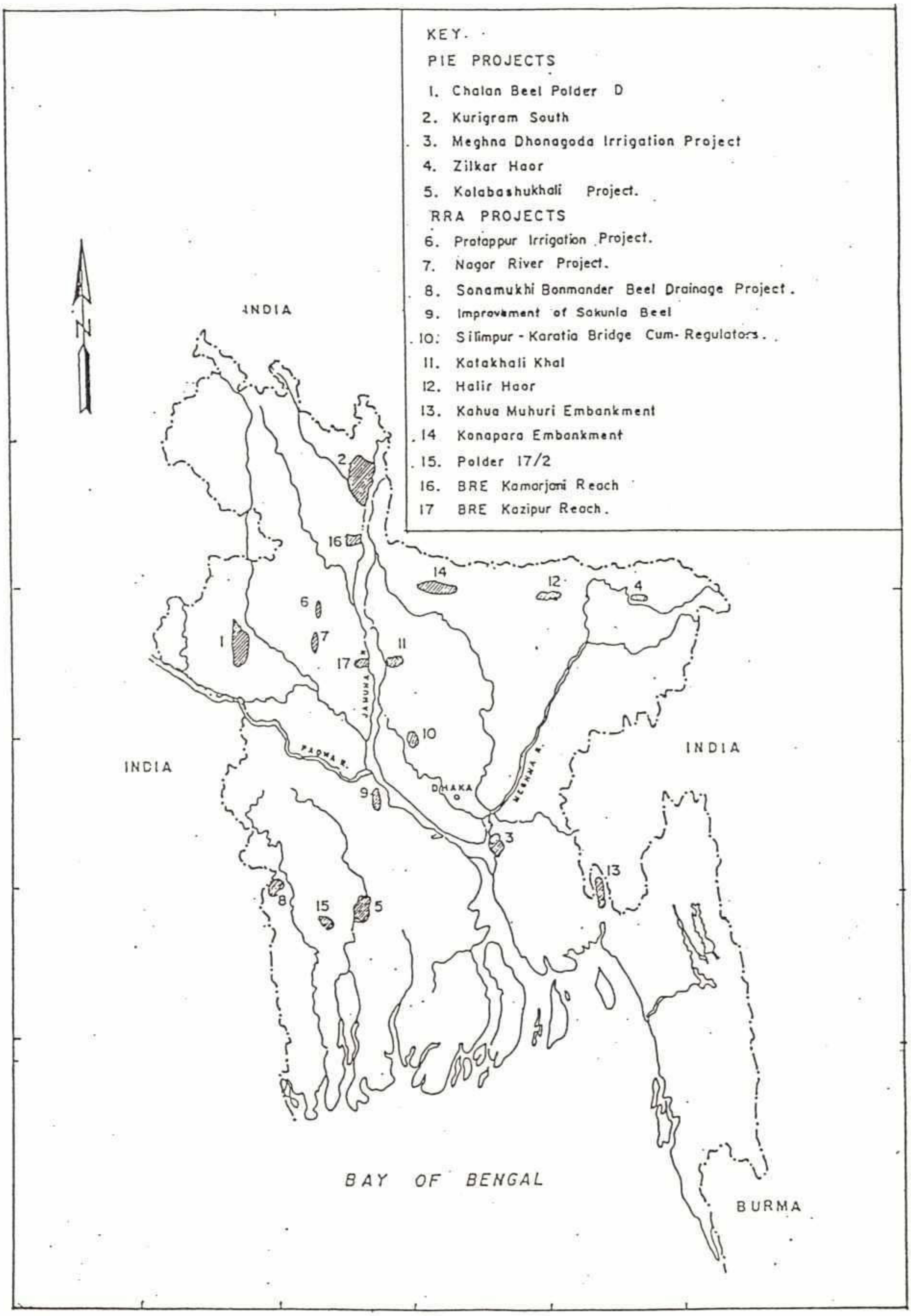
FAP 12 made explicit use of RRA techniques in its evaluations of 12 projects, and in preliminary RRAs which preceded the full PIE surveys at the other 5 projects. The core of the approach is the collection of data by a multi-disciplinary team of well-qualified and experienced specialists, working together in the field, usually for about a week, using a range of techniques to collect and cross-check data ("triangulation"), talking with and interviewing a wide range of informants and reaching informed judgements in the field. An essential aspect of RRA is thorough study of existing data sources before the field work phase.

The RRA fieldwork was completed on schedule, but the process of reporting took considerably longer than had been anticipated. The approach is considered to have been successful in producing evaluations quickly and relatively cheaply, and to have been particularly effective in giving an integrated multi-disciplinary perspective, and a qualitative evaluation of project impact. It was possible to quantify some of the key parameters, but at times these represent broad "guesstimates" rather than precise data.

S2.4 Project Impact Evaluations

The Project Impact Evaluations (PIEs) involved the comparison of conditions in areas benefited by the projects (impacted, protected areas) with conditions in adjacent areas that may have also been affected by the project (impacted, unprotected areas) and areas where pre-project conditions had been similar, but no project impact was felt (control areas).

Figure S1 Location of Selected PIE and RRA Projects



Source: Consultants

Table S1 Key Features of PIE and RRA Projects

Project Name	Project Type	Region	District	Gross Area (ha)[1]	Complet-ion Year	Funding Agency	Level of Study
Chalan Beel Polder D	FCD (Polder)	NW	Rajshahi/Naogaon	53055	1988/89	IDA	PIE
Kurigram South	FCD (Main River Embankment)	NW	Kurigram/Lalmonirhat	63765	1983/84	GOB	PIE
Meghna-Dhonagoda Irrigation Project	FCDI	SE	Chandpur	17584	1987	ADB	PIE
Zilkar Haor	Submersible Embankment	NE	Sylhet	5263	1986/87	NTAP	PIE
Kolabashukhali	FCD (Saline exclusion)	SW	Khulna	25466	1983	IDA	PIE
Protappur	FCDI	NW	Bogra	5200	1977/78	GOB	RRA
Nagor River	FCD	NW	Bogra/Natore	15400	1986	EIP	RRA
Sonamukhi-Banmander Beel	D	SW	Jessore	9000	1978	GOB(?)	RRA
Sakunia Beel	FCD	SC	Faridpur	5700	1985	GOB	RRA
Silimpur-Karatia Regulator & Bridges	FCD	NC	Tangail	2833	1983	IDA	RRA
Katakhali Khal	FCD	NC	Jamalpur	>2660	1982/83	EIP	RRA
Halir Haor	Submersible Embankment	NE	Sunamganj	>8000	1983	IDA/WFP	RRA
Kahua-Muhuri Embankment	Flash Flood Protection + Irrig.	SE	Feni	2638	n.a.	n.a.	RRA
Konapara Embankment	Flash Flood Protection	NE	Mymensingh	3480(?)	1983/84	EIP	RRA
Polder 17/2	FCD (Saline Exclusion)	SW	Khulna	3723	1983/84	GOB/EIP	RRA
BRE - Kamarjani Reach	FCD (Main River Embankment)	NW	Sirajganj	10100	1970	IDA	RRA
BRE - Kazipur Reach	FCD (Main River Embankment)	NW	Sirajganj	10500	1970	IDA	RRA

Source: FAP 12 RRA Overview Report

Notes: [1] Sometimes best estimate only.

Funding Agencies:

IDA - International Development Association (World Bank)
GOB - Government of Bangladesh
ADB - Asian Development Bank
NTAP - Netherlands Technical Assistance Programme
EIP - Early Implementation Project (Netherlands/Sweden)
WFP - World Food Programme

The core of the PIEs was a questionnaire survey of households, using formal probability sampling for selection of households in the main survey. The strength of such an approach, in contrast to RRA and other non-probability survey techniques, is that the results produced can be interpreted with known levels of precision and confidence.

The PIEs also involved a number of other questionnaire surveys, covering fishermen, traders and operators of other non-farm economic activities, who were sampled purposively because of the difficulties of assembling sample frames for these groups. Because of the absence of probability sampling, these surveys constitute sets of case-studies which illustrate the processes at work but cannot support statistical testing.

The PIE surveys were carried out over a five month period (from May to October 1991) and involved over 1800 interviews. The surveys succeeded in providing quantitative data on the key variables related to project impact which are precise enough to permit considerably more confident evaluations than was possible through the RRAs. Nevertheless it was noticeable that in none of the cases did the overall qualitative conclusion on degree of project success change, and one of the key methodological conclusions is that there is considerable benefit to be gained from preceding a PIE with a diagnostic RRA.

S2.5 Assessing Overall Project Impact

Project impact was judged by a wide range of criteria, ranging from the direct impact on hydrological conditions to the resulting changes in agriculture, fisheries, livestock, ecological, social and economic parameters. These impacts were synthesised in two ways.

For the five PIEs, and for some of the RRAs, a Preliminary Environmental Post-evaluation was carried out, bringing together physical, biological and human environmental issues. This level of evaluation is adequate to identify projects which have had negative environmental impacts that are serious enough to warrant further enquiry (such as an "environmental audit"), and to permit identification of any mitigatory measures that are required.

An economic analysis of project impact was carried out in every case, although in the RRAs the analysis was sometimes based on very broad estimates of costs and/or benefits. The economic analyses generally followed the methodology recommended in the FPCO Guidelines for Economic Analysis (1991), and made considerable use of MPO data on Agricultural Production Systems (1987). In most cases the analyses were confined to quantification of agricultural benefits and of fisheries impact (usually disbenefits). The sensitivity of the results to plausible variations in the main parameters was usually tested.

No case was found in which the overall conclusions from the economic analysis differed from the more qualitative and broader based judgements in the environmental evaluation.

S3 FACTORS LIMITING IMPACT EVALUATION

The FAP 12 team have reached conclusions on a wide range of issues relating to the impact of FCD/I projects. In general the impacts observed are supported by a wide range of observations, and many have been identified by previous evaluations. Nevertheless the team has been well aware of the limitations of impact evaluations.

Diversity - the diversity of FCD/I projects, and of their impacts, is such that any attempt at generalisation is likely to require qualification.

Complexity - many FCD/I projects are extremely complex, in terms of their hydrological features (their impacts on the depth, timing, location, speed, probability, salinity and sediment load of floods, for example) and in their consequent impacts on agriculture and other activities.

Separability of Impacts - agricultural, economic and social development in most FCD/I areas have been affected by other factors as well as by the FCD/I project. In particular the expansion of groundwater irrigation has had a major impact in many areas. It is often difficult to distinguish the impact of flood protection from the impacts of other interventions on the rural economy.

Externalities - during the RRAs it was usually impossible to explore the off-site impacts of the projects visited, and even for the PIEs it was very difficult to quantify off-site impacts that were identified.

Control Areas - although control areas were used in the PIEs as a guide to "without project" conditions it was difficult in several cases to identify a control which had both been a replica of the project area in pre-project times and had remained undisturbed subsequently. In addition, in some cases an area that was an acceptable agricultural control was less strictly comparable from the viewpoints of other disciplines, such as fisheries.

Timing - several issues related to timing constrain evaluations. In some cases the length of time since the project was complete made it difficult to obtain data on pre-project conditions. It was generally difficult to trace the timing of build-up of project impacts, and during the RRAs it was found that it was sometimes difficult to overcome "season bias". It was concluded that a first step in improving on basic RRA analyses would involve multiple visits to each project, at different times of the year. For a comprehensive picture of long-term developments a series of RRAs documenting changes during the project lifespan would be required.

Quantification and Confidence Limits - during some of the RRAs the quantification of project impacts was found to be particularly difficult, and some of the figures used for their economic analyses were based on broad estimates. It was found that in some cases the results of the economic analyses were sensitive to very small changes in the crop yield estimates in particular, and in such cases the economic evaluations had to be treated with caution. The PIEs had the advantage of permitting quantification of confidence limits for data from the main probability samples, but even in these it was sometimes found that the variability in reported data was so great that apparent differences between, for example, control and impacted area yields, could not be verified with useful levels of confidence.

Project Objectives - Assessment of project impact must start from project objectives. In many cases these were inadequately defined, or limited only to expected agricultural impact, making it difficult to compare planned and actual outcomes.

Project Documentation - some of the projects evaluated were very poorly documented, and original feasibility studies, Project Proforma (PP) or designs could not be traced. In general it was not possible to locate as-built drawings, an essential requirement in the evaluation of engineering structures.

S4 THE IMPACT OF COMPLETED FCD/I PROJECTS

S4.1 Planning, Design and Implementation

Project planning was generally carried out by BWDB or by consultants, with little or no collaboration with other relevant Government Departments or with the intended beneficiaries. However, in the few cases when there was local consultation at the planning stage, projects were generally better conceived, and their implementation and subsequent operation were facilitated.

The planning of some of the projects was carried out without undertaking essential regional hydrological studies. With the increasing concentration of FCD projects, especially in the North-West and South-West Regions, such studies are vital for obtaining warning of adverse external impacts on water levels. Fortunately the FAP now offers an opportunity to overcome this past weakness.

Embankment alignments were sometimes poorly planned, leading to failures and frequent retirements. The multiple use of embankments was rarely taken into consideration at the planning stage. On some occasions there have been proposals at the planning stage to include navigation locks in embankments, but these have almost invariably been discarded before construction (the sole known exception being the Chandpur Irrigation Project).

Designs for embankments and structures at most projects were generally found to be sound, given the purposes defined by the planners. However designers sometimes had inadequate data on hydrological and subsoil conditions, and as a result their designs have at times proved inappropriate and led to physical failures.

Many of the design problems that have been identified relate to drainage. Almost all the projects suffer from moderate to severe drainage congestion due to faulty hydrological assessments and the absence of an adequate drainage network. A common symptom of drainage problems is public cuts and these are often so serious that they compromise the scheme's viability.

Regulator gates were found to be leaking everywhere and the use of wooden fall-boards on some projects was found to be ineffective.

Most of the projects took longer to implement than the period originally specified, and this usually resulted in cost overruns. Despite long implementation periods it was noted that there were no procedures for review of plans, although changes in conditions should have been reflected in adapted proposals.

On several occasions projects were not constructed as designed. Reasons for this could rarely be identified. Embankment compaction was often inadequate. Drainage canal excavation was almost invariably either inadequate or not implemented at all. Internal road development, where planned, was usually curtailed during design and/or construction.

S4.2 Operation and Maintenance

Inadequate operation and maintenance (O&M) is the most frequent immediate constraint on effective achievement of FCD/I goals. The problems identified have been more thoroughly explored in the companion study by FAP 13. Three key issues relating to O&M

are: resource constraints; the poor quality of infrastructure maintenance which results partly from lack of finance; and the almost invariable absence of public participation in either operating practice or maintenance.

Domestic financial resources are limited but the shortage is exacerbated by using them to pay for excessive staff establishments and to cover O&M requirements which are excessively high because of deficiencies in planning, design and implementation. As a result many of the FCD/I projects studied were in a poor state of repair. Routine and preventative maintenance is almost non-existent, and is replaced by emergency measures and periodic rehabilitation, which can be funded from external sources, often after a damaging event.

However the poor quality of the maintenance activities that are carried out suggests that O&M could be significantly improved with the existing resources, particularly if local participation can be directly harnessed for maintenance. O&M manuals that have been prepared are not used. The most important maintenance and repair activities, repairing and retiring embankments, are carried out using FFW resources and are poorly supervised by BWDB. As a result compaction standards are poor and design standards are not followed.

Most FCD/I structures are operated more or less as anticipated, where their physical condition permits it. However the local committees often envisaged to participate in operation have rarely been established effectively, and operation is frequently carried out under the influence of powerful local individuals. In some areas operating practices are the subject of serious dispute, when different interests, for example shrimp farming and paddy farming, dictate different operating practices.

S4.3 Flooding, Drainage and Irrigation

Almost all the FCD/I projects evaluated have at least partially achieved their hydrological objectives. The only major exception was the Nagor River Project in the Atrai Basin, which was based on inadequate understanding of the regional hydrology, and is subject to persistent embankment cuts.

As noted earlier, there are numerous parameters to flood control, and each project had site-specific objectives. In general attempts to delay early floods were usually successful, and in many projects normal monsoon season flood depths were also reduced.

Projects aimed at salinity exclusion were also generally successful, although they sometimes led to social conflicts between shrimp growers and rice farmers.

The achievement of drainage objectives was more variable. The poor implementation and maintenance of drainage infrastructure undermined the possibility of achieving these objectives at some projects, and at others the FCD/I infrastructure exacerbated drainage congestion problems.

Several projects had modest irrigation objectives, which were often achieved. The more ambitious surface irrigation system at Meghna Dhonagoda has had a dramatic impact in the area and is widely used by the beneficiaries. However at some of the other sites subsequent development of groundwater irrigation has replaced the project's irrigation role.

S4.4 Agriculture

The major impact of FCD/I projects has been on cropping patterns in the kharif season. Reduced flood depths and durations have led to a move from B Aman or Aus/Aman to TL Aman and T Aman HYV, and sometimes from B Aman to Aus followed by T Aman.

In general, changes in cropping patterns made possible by FCD/I interventions tend to increase the preponderance of paddy, as this is the main monsoon crop and it generally gives the highest financial returns.

Where flood control has protected the Boro crop from early flash floods this has promoted expansion of L. Boro and adoption of HYV Boro, but this phenomenon is limited to certain geographical locations (haors in the north-east, for example).

In some areas reduced average annual flood losses have increased annual mean harvested yields of the same crop varieties, but this has not always occurred, and is difficult to quantify.

FCD/I projects have rarely resulted in increased cropping intensities, largely because any land which is cultivable in the monsoon season is already used, even if only with low-yielding varieties. In many "successful" projects the cropping intensity has actually fallen - when a rabi/Aus cropping pattern is replaced by a single Boro crop for example. This is, however, often an effect of the irrigation, not the FCD, component of such projects.

Where flood protection is effective there is evidence that increased levels of inputs are applied, both to paddy HYVs and to other crops.

Coordination between BWDB and DAE in the planning, design, implementation and operation of projects has generally been inadequate or absent. This remains an area for future policy intervention.

S4.5 Livestock

Project impacts on bovine populations are complex. Bulk fodder availability tends to be adversely affected by FCD/I projects as a side-effect of their impact on crop production. Grazing opportunities are reduced where there are fewer crop losses, and switches to HYV paddy varieties (whose stiff straw has high lignin and silica content) lead to poorer fodder supplies. On the other hand, in agriculturally successful projects where cash availability is increased, farmers spend more on livestock feeds, with the increase weighted towards concentrate feeds of high nutritional content. There is no clear pattern of impact on small stock and poultry.

Draught power requirements have risen with the introduction in larger areas of transplanted Aman, and medium and large farmers in particular (who reap most of the agricultural benefits) are facing draught power shortages which they have tended to meet in the short term by using cows for draught purposes, and in the longer term by switching to power tillers for land preparation.

S4.6 Fisheries

FCD/I projects have usually had a major negative impact on capture fisheries, resulting from substantial reductions in the areas of regularly inundated floodplains, in the areas of permanent beels and in the blockages to past fish migration routes. Many fishermen have lost their livelihoods, or been diverted to river fisheries, leading to overfishing in these areas which are also adversely affected by the changes in fish migration potential. The magnitude of these losses in most cases appears to be substantially greater than has been previously estimated, and in some cases to be sufficient to severely reduce the economic performance of projects which appear viable on agricultural performance alone.

The absence of integrated flood control and fisheries planning has led in some cases to acute social conflicts between fishermen and farmers.

Flood control has provided opportunities for development of culture fisheries, which are being taken in some areas. However the benefits from these do not go to the disbenefited capture fishermen, and the scale of fishpond production has yet to compare with the decline in the capture fishery.

S4.7 Non-Farm Economic Impact

FCD/I infrastructure has both a direct and an indirect impact on non-farm economic activities. The direct impacts relate to communications and to employment in construction. In many projects the embankments provide an important communication network, and have stimulated the development of road transport, and subsequently improved the marketing infrastructure and access to social and other services. In about half the projects studied by FAP 12 there has been a negative impact on navigation, as previous waterways have been closed. In some cases this has seriously impeded freight transport within the project area. In general road transport benefits outweigh water transport disbenefits, but the benefits and disbenefits do not accrue to the same groups.

The construction and maintenance of the FCD/I infrastructure, and of embankments in particular, has a substantial employment impact and particularly benefits the landless and disadvantaged women.

The indirect impacts arise mainly through the project's initial impact on agricultural production. This in turn stimulates input marketing, rice trading, milling and the production of implements. During the PIE studies it was noticeable that those projects which were believed to have had the greatest impact on output were also those with the greatest apparent impact on non-farm economic activities.

S4.8 Impact on Women and Gender Roles

Women's issues were not at all focussed on in project feasibility studies and planning, nor was there any objective in FCD/I projects for women's development. There are, however, a number of changes that have been caused directly or indirectly by the implementation of the projects.

The project impacts on women could be divided into two broad categories:

i. those that have directly resulted from the projects, such as embankment maintenance; and

ii. those that resulted from linkage effects, such as increase in post-harvest activities due to increased agricultural production within the project area.

As regards direct impact, the projects in general provided employment for embankment repair and maintenance work and in some cases drainage channel excavation work under the FFW programme.

In most spheres of women's activities their traditional roles remain unchanged. But the increased volume of paddy production in most projects also increased women's work load and work opportunities for post-harvest processing. Improved road connections provided by the embankments facilitated NGO development activities, some of which are especially directed towards women. However, in many cases the role of women in paddy husking has diminished due to the spread of mechanised rice husking and consequently the role of men has increased. It is difficult, though, to relate this change to the project intervention.

One may expect that the higher output growth in the project areas would lead to better nutrition for women. Little systematic difference between rice intakes of adolescent boys and girls could be observed in both impacted and control areas. Adult women on the other hand were found to consume about 25-30 per cent less than adult men irrespective of whether the samples are drawn from the impacted or control areas.

Irrespective of the type of household they come from women, during floods, suffer from several major problems. These are lack of dry space, drinking water availability, sanitary facilities, food availability and cooking and movement.

S4.9 Social Impact

The successful FCD/I projects have all stimulated employment, in both agrciultural and non-farm activities, and all FCD/I interventions provide substantial employment oportunities in construction, as has been noted. Such employment accrues for the most part to the men and women of wage labour households.

The benefits from the projects are not, however, evenly spread. Capture fishermen and boatmen are usually the greatest losers, while agricultural production benefits tend to accrue particularly to the larger landowners. No FCD/I projects have included measures to mitigate the negative impacts on specific groups, even when these were clearly anticipated at the planning stage.

Land acquisition processes have been a common source of dissatisfaction during FCD/I development. The complaints generally related to the process of land acquisition rather than to the levels of payment.

FCD/I projects have frequently exacerbated social tensions in the impacted areas, between insiders and outsiders, between farmers and fishermen, between farmers and boatmen and between farmers at different land levels. In many cases these conflicts recur annually, and local conflict resolution arrangements are clearly inadequate.

The FCD/I projects studied had usually provided increased security from flood hazard which was highly appreciated by the beneficiaries. Many had nevertheless suffered from flooding events since construction, associated with high floods, with river erosion or with embankment failure. In these cases it was noted that, contrary to expectations, the cost of damage within protected areas was higher than the costs suffered in control areas in the same events. For crop damage, this is due to the higher velocity of water flows following embankment failure, compared with those in an unprotected situation, while for property damage this suggests either increased wealth in impacted areas or a tendency to establish homes or enterprises in locations that would have been known to be at risk in the absence of flood protection.

A further important role played by the flood embankments is as safe refuges during flood events, and in many cases as locations for housing for those displaced by river erosion.

S4.10 Environmental Impact

Environmental evaluation for all 17 FAP 12 projects was carried out by initial screening and scoping, followed by a more detailed preliminary environmental post-evaluation for the five PIE projects. The environmental impacts of the projects were assessed in terms of three categories of issues: physical, biological and human, evaluated in both the project areas and in external impact areas affected by the projects. In some cases external (off-site) impacts comprised the incremental effects of a project, taking into account the combined contributions from other geographically related FCD projects.

The most common positive direct environmental impacts were:

- reduced flooding, in terms of level, timing, rate of rise, duration and extent of floods;
- improved soil moisture status at critical periods, due to reduced wetness in the monsoon and, in some cases, to irrigation or water retention for post-monsoon and dry-season use;
- improved land capability through the reduction of flood hazard and increased cropping severity and flexibility;
- increased land availability due to the reduced extent of wetlands;
- improved opportunities for culture fisheries;
- greater opportunities for afforestation and other tree-planting;

These in turn have provided significant benefits to the human populations, including:

- substantial rises in human carrying capacity;
- some improvement in human health and nutrition;
- greater protection for infrastructure, with increased human safety and diminished disruption;

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- improved access and communications, if only via the embankments themselves;

- substantial, if somewhat inequitable, economic benefits to the people in terms of incomes, employment, land values and credit-worthiness;

- generally favourable social attitudes to the projects, despite many complaints;

- overall improvement in the quality of life due to these positive physical and socio-economic impacts.

The most common negative environmental impacts were:

- cumulative influences in the external areas in increasing river flows, bank erosion and bed scouring, siltation, and flooding levels;

- drainage congestion due to inadequate design, operation and maintenance of drainage structures and channels;

- high risk in specific areas of certain projects of future catastrophic flooding, with associated hazards to infrastructure, life and property;

- possible decline in the quality of subsurface, river and wetlands waters, and thereby domestic water supplies (although data to quantify this impact are generally lacking);

- reduced extent of wetlands, which is ecologically negative;

- decline in soil fertility due to diminished aquatic vegetation and micro-biota;

- contribution to the general decline in fish ecology and capture fisheries;

- in one or two study areas, contribution to a continuing decline in bird communities and habitats;

- some decrease and deterioration in the livestock sector;

- loss of land to the embankments and other project works, often with inadequate compensation;

- disproportionate distribution of project benefits and disbenefits, causing some strains on social cohesion.

Any attempt to assess the biological impacts of FCD projects has to take account of parallel trends that were initiated long before such projects were conceived. These are essentially the trends associated with the accelerated increase in population pressure both on the physical resources which provide biotic habitats and on the biotic communities themselves. Cultivation, land settlement, vegetation clearance, hunting and fishing have all increased in the study areas as population density has soared over the last few decades. In recent years, nationwide disease has added to the effects of intensive overfishing to cause a general decline in fish ecology. Thus while FCD projects undoubtedly contribute to ecological decline, they seem rarely to be the major factor concerned.

S4.11 Economic Impact

The projects evaluated have shown an enormous range in their estimated economic returns, with 8 showing unacceptably low returns (an EIRR below 12 per cent), while 7 had EIRRs of 30 per cent or more (Table S2 and Figures S2 and S3).

With the exception of Meghna-Dhonagoda all the projects had capital costs (in 1991 financial prices) below Tk 18 000 per benefited hectare, and the level of capital costs did not correlate with project "success". Annual O&M costs were usually in the range of Tk 100 to Tk 600 per hectare (again excepting Meghna-Dhonagoda), and there was no evidence that those with higher O&M expenditures were more effective.

The two factors that were critical to project "success" appeared to be the net economic benefits (agriculture benefits minus fisheries losses, where these were encountered) (Figure S2) and the implementation time (Figure S3). All projects that had a net annual economic benefit per hectare of over Tk 2000, and were completed in four years, or less achieved EIRRs of 30 per cent or more. The seven most successful projects were all small (9000 hectares or less in gross area) and relatively simple in conception and design. The eighth most successful project, Kolabashukhali, was in many ways similar to these, as it was also based on a simple approach and design, although it was substantially larger (over 25 000 hectares). Kolabashukhali was also (almost uniquely for a large project) completed within budget and on time.

Meghna-Dhonagoda, also a large project, is technically in a class of its own, due to the provision of pumped drainage. Financially it also stands apart, capital costs per hectare being nearly ten times those of the next most expensive project, while O&M costs are at least three times higher (Table S2). The agricultural benefits are impressive, but the project is economicall non-viable. Its economic performance is worsened by a history or delayed completion, cost overruns and early breaches, but its non-viability is fundamentally due to the inability of the highest conceivable level of agricultural benefits to cover the very high costs. The implication is that pumped drainage, despite its technical attractions, is not suitable for widespread adoption.

Table S2 **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 (all)	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.

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Figure S2 EIRR and Implementation Period
(negative EIRRS indicative only)

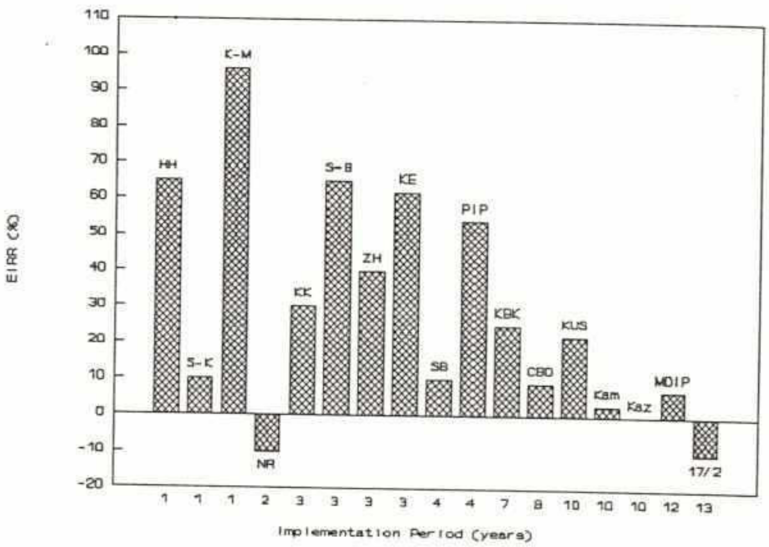
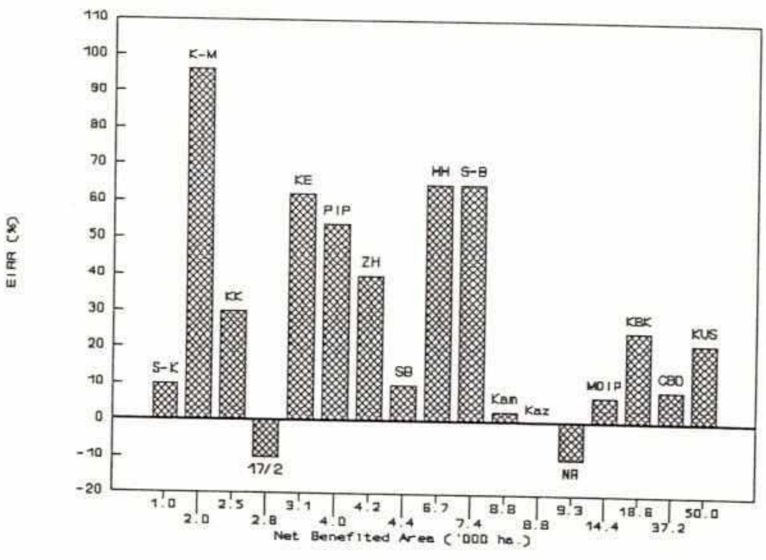


Figure S3 EIRR and Net Benefited Area
(negative EIRRS indicative only)



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 S4 EIRR and Capital Cost
(negative EIRRS indicative only)

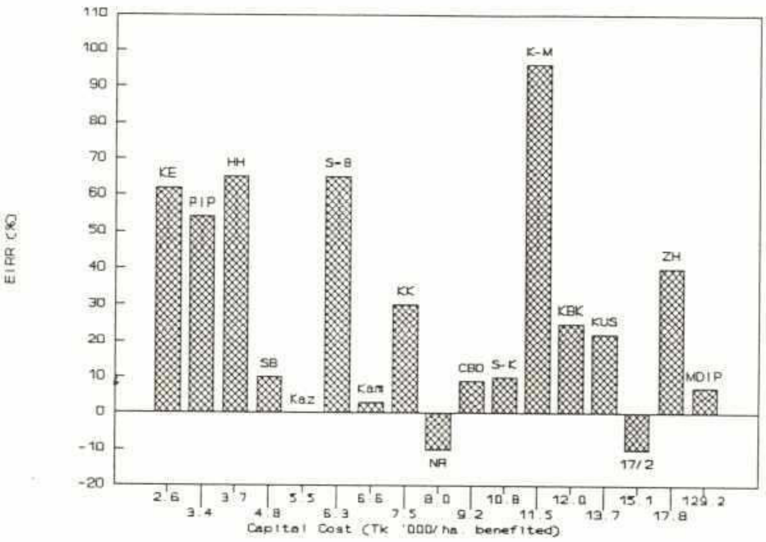
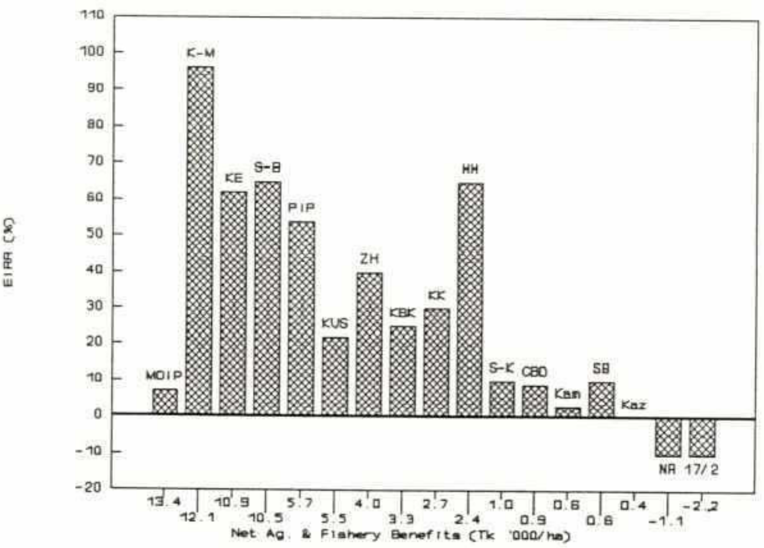


Figure S5 EIRR and Net Agricultural and Fishery Benefits
(negative EIRRs indicative only)



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		

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S5 RECOMMENDATIONS

S5.1 Project Planning and Design

S5.1.1 The Planning Process

i. In project selection priority should be given to small projects which represent an evolution of local practice and are modest in their engineering interventions and costs. In particular, expensive pumped drainage schemes should not be accepted.

ii. Project planning must take into account not only within project (on-site) impacts but also external (off-site) impacts. The latter usually occur in adjacent rivers and the land beyond them, and in downstream rivers and areas. Planning of FCD projects must be guided by regional hydrological models which can predict these impacts.

iii. Before implementation of Coastal Polders morphological studies of tidal rivers are necessary to allow designs to minimise siltation problems.

iv. The planning process must involve wider consultation than has been the case in the past, including a wider range of Government Departments (including agriculture, fisheries, forestry, livestock and roads and highways), local authorities, NGOs and the expected beneficiaries. This process should include public meetings at which the proposed interventions, and their implications, are clearly explained and discussed. FCD/I projects located near the international border require collaboration with India to ensure realistic project design.

v. It should be emphasised that the consultation process should not only permit BWDB and FAP planners to accommodate the responses of others. It should also facilitate the introduction of complementary activities by other agencies - in agricultural extension and promotion of culture fisheries for example. More integrated planning of roads and embankments is particularly essential.

vi. The planning stage of all FCD/I projects should include a benchmark survey. The survey should provide a basis for identifying trends of change, as well as describing the existing situation.

vii. Planners must, in particular, be clear about the characteristics of FCD/I pre-project hydrology, the consequent impact on agriculture, and how these characteristics are expected to change following the FCD/I intervention. Only then can expected impacts be confidently predicted.

S5.1.2 Embankments and Structures

i. Embankments should be designed for multi-purpose uses, which may include roads, housing, emergency shelter for flood victims (human and livestock), tree plantation (for fuel, fodder, fruit and above all protection), vegetable production, forage crop production and transhipment of goods.

ii. Structures on submersible embankments should be designed for operation with sizeable head differences.

iii. Where regulator gates are intended to retain water for irrigation purposes or to stop intrusion of saline water they need to be equipped with watertight seals. Wooden fall-boards are generally inappropriate as the primary means of water control for regulators.

S5.1.3 Drainage Planning

i. The planning of drainage networks and drainage regulators for FCD/I projects requires more intensive investigations of existing drainage conditions than have been carried out in the past.

ii. Drainage channels need to be designed with enough crossing points to avoid disruption of existing communications.

iii. The possibility of using borrow-pits, excavated beels, khals and drainage channels as water storage units or for fisheries should be considered at the planning and design stages.

iv. Completed projects which experience frequent public cuts, usually as a response to drainage congestion, should be reassessed and if necessary the original planning and design objectives should be modified. Compartmentalisation may be the answer to these problems at some locations.

S5.1.4 Planning for Emergencies

i. When planning projects in Haor areas, nonstructural measures such as safe places for housing, secure in extreme floods, should be provided.

ii. Emergency planning for over-design events (particularly for cyclones in coastal areas, and embankment failures everywhere) should be incorporated into FCD/I plans.

iii. It is essential to develop means of warning people who settle in lower locations than in the pre-project period, that their sense of security may not be fully justified, and that their property remains at risk during high flood events.

S5.2 Construction

i. The quality of embankment compaction must be monitored carefully by BWDB. Research on improved low cost compaction methods is needed.

ii. In major embankments mechanical compaction may be necessary, both when originally constructed and if they are reconstructed as retired embankments.

iii. Systematic methods of record keeping, and storage of project documents, including feasibility and design studies and as-built drawings, need to be introduced at BWDB field offices.

S5.3 Agricultural Planning

i. When the irrigation component of a FCDI project is aimed at promoting rabi season development, the relative advantages of surface and groundwater irrigation must be very carefully weighed. Long-run O&M costs for surface irrigation may be lower than for groundwater, but groundwater irrigation is more flexible, managerially less complex and offers much better practical scope for cost-recovery, and is therefore more likely to be sustainable.

S5.4 Livestock Planning

i. As FCD/I projects have been shown to lead, in some circumstances, to declines in cattle populations, the implications of this need to be considered in FCD/I planning - for draught power requirements, nutrition and net increases in agricultural incomes.

ii. Urea treatment of straw and use of urea-molasses blocks has potential for improving the utilisation of increased straw output from FCD/I projects for cattle nutrition. A large-scale field trial, building on existing research, should carried to to test their feasibility and safety.

S5.5 Fisheries

i. Where an FCD/I project is expected to have a negative impact on capture fisheries mitigatory measures to promote culture fisheries schemes both for the benefit of former capture fishermen as well as for pond owners should be included in the project.

ii. In future beels should be protected as far as possible, and should be reexcavated and improved instead of being drained, in order to maximise their fishery potential.

iii. Where it is feasible, sluices and drainage outlets should be designed to facilitate fish passage after pilot scale trials to verify their effectiveness.

iv. Those planning coastal polders where shrimp farming is likely to be involved or affected should use the experience of the shrimp farming projects (e.g. World Bank financed Shrimp Farming Project) which show that paddy farming and shrimp culture can co-exist.

v. Where project designs include or could include retention basins and use of khals for water storage (for irrigation, for example) these should be sized and operated as far as possible to provide a permanent stock of fish.

S5.6 Gender Aspects

i. Women's positions and roles in society are determined mainly by tradition and custom, and a general economic improvement due to successful FCD/I measures may not necessarily improve their lot. Hence, for any improvement of their situation, activities aimed specifically towards women are required.

ii. Means of including job opportunities for women (particularly the widowed and divorced) should be considered during project planning.

S5.7 Social Aspects

i. Action is necessary to ensure that khas lands made cultivable by FCD are leased to the landless. The involvement of NGOs in the process is probably essential.

ii. Where any social groups are expected to disbenefit as a result of FCD/I interventions specific mitigatory measures should be included and costed in the project design.

iii. Where people have to be resettled because their land is acquired for embankments they could be involved in embankment construction, provided with house lots on the embankment, given responsibility for O&M of embankment reaches and/or allowed to exploit social forestry opportunities.

iv. NGOs should be actively involved in these, and in other aspects of O&M activities, such as social forestry.

S5.8 Ecology

i. Certain large projects may include sites of special ecological interest. In these cases consideration should be given to the possibility and cost of protecting these within the project.

ii. External (off-site) ecological and environmental impacts may sometimes be important and should be explicitly anticipated at the planning stage.

S5.9 Economic Analysis

i. All benefits and disbenefits, including those from flood protection, should be quantified and costed wherever possible. Where benefits are expected to arise from increases in rabi crop production, and in particular from increased output of HYV Boro, these must be particularly critically verified.

ii. The delays likely in project implementation should be assessed realistically in project analyses, and in large and complex projects the sensitivity of the EIRR to ten-year implementation periods should be tested.

iii. Economic analyses must include sensitivity analyses to examine the impact of plausible changes in costs, fisheries losses and, in particular, differences from the basic yield assumptions of the main crops.

S5.10 Operation and Maintenance

Recommendations from the FAP 13 study are summarised.

S5.10.1 Public Participation

i. Responsibilities and rights need to be clearly defined and divided between public agencies and the beneficiaries and users of FCD/I projects, with clear lines of communication between both sides.

ii. Resources and professional social organisers are needed to facilitate public participation in and to build up local institutions for system management.

iii. An ability to generate resources and greater local control of the resources created by FCD/I is needed to increase local accountability in management.

S5.10.2 Transition Period

i. A formal transition and hand over from implementation to management (O&M) division/agency would help in preventing scarce maintenance resources being used for correcting planning, design or implementation defects.

ii. As-built drawings of project structures and practical guidance on O&M should be handed over to the system management.

iii. Training and technical assistance in this period should cover: training of social organisers and system employees, and practical training and advice for user groups - in operation, routine maintenance, and associated productive enterprises (such as tree or fish cultivation).

S5.10.3 Maintenance

i. Routine earthwork maintenance is needed, alternative approaches are employing women's maintenance teams or linking maintenance requirements to productive use of embankments and channels. In this, and in periodic maintenance, greater effort should be made to target employment creation directly to disadvantaged groups.

ii. Regular monitoring of embankments and structures is needed so that danger areas can be upgraded before it is too late, so avoiding excess damage, probably loss of life, and high rehabilitation costs. This will require improved prioritisation of funds, and greater discretionary funds for system managers to speedily carry out preventative emergency repairs.

S5.10.4 Resource mobilisation

i. Experiments are needed in mobilising resources for O&M by: payment of fees, leasing of infrastructure use to raise revenue directly for O&M, self-contribution of resources by beneficiaries, and making proper maintenance conditional on use of infrastructure.

ii. Housing on embankments could be permitted if it is planned for, linked with maintenance duties for the settlers, and does not affect the main purpose of the embankment.

iii. Self-sustaining uses of FCD/I infrastructure could reduce O&M costs and create additional benefits. Productive use of embankments, and managed capture or stocked fisheries will require experimental development of suitable institutional arrangements and should not adversely affect the FCD/I objectives of projects.

S6 AREAS FOR FURTHER INVESTIGATION

S6.1 Engineering Design and Hydrology

i. The application of compartmentalisation approaches to haor areas appears to offer promising benefits, and deserves detailed investigation.

ii. The use of fixed weirs or spillways for water regulation should be studied, as an alternative to regulators with moveable gates, as fixed structures are cheaper, more durable and less susceptible to incorrect operation.

iii. It is alleged that rising river beds are threatening the submersible embankments at their current heights. This requires investigation by FAP 6.

iv. There is frequent speculation about the impact of Flood Control on groundwater resources but little data on which to base this. A detailed monitoring programme would be required to provide a firm basis for evaluating these impacts.

v. The scope for and benefits to irrigation in saline-exclusion polders should be investigated.

vi. Important changes in river morphology in adjacent and/or downstream rivers are often alleged or inferred to arise from FCD/I interventions. These specifically include accelerated bank erosion and depth reduction due to siltation. A detailed monitoring study of relevant rivers is required.

S6.2 Agriculture

i. Applied research is required into improved paddy drying and processing methods, especially for application in Haor areas.

S6.3 Fisheries

i. Research is needed into the best means of reviving fish stocks in rivers throughout Bangladesh.

ii. There is a great lack of reliable data on the productivity of all capture fisheries. Data on area and status of water bodies and fish ponds needs to be brought up to date. Additional studies are needed into fishery resources, production and marketing. Detailed long term studies are needed if the magnitude of FCD/I impacts on fisheries is to be quantified accurately.

iii. Applied research is needed into the effect on fish stocks of drying out beels using LLPs.

iv. New approaches to fisheries leasing systems need to be investigated, with the aim of enabling fishermen to manage the fisheries sustainably.

S6.4 Gender Aspects

i. Research is needed into the differential mechanism for coping with extreme stresses during flood by men and women. Another topic of importance for future studies is an assessment of relative roles of tradition, and other factors (economic, demographic) in determining intra-household food intake at various levels of economic well-being. Both of these will facilitate framing of future policy options to improve the position of women.

S6.5 Social Aspects

i. Legal issues related to land revenues need to be resolved, and procedures for compensation payments need to be accelerated. FAP 15 is covering these issues.

ii. It has been suggested that land speculation can lead to unintended and inequitable distributions of FCD/I benefits. Further study may be needed to verify this hypothesis, and, if necessary, to identify possible ways of avoiding this.

S6.6 Environment

i. Research should be undertaken into appropriate flood tolerant trees for planting on submersible embankments.

ii. Given the continuing widespread belief that FCD/I projects lead via reduced flooding and silt deposition to declining soil fertility and deteriorating soil physical characteristics, further investigations are essential.

iii. Project impacts on public health are at present indeterminate, though FAP 12's limited studies suggest they are on balance positive. More detailed investigations are justified.

iv. Detailed monitoring is required of water quality in representative on-site and off-site wetlands, rivers and groundwater to assess project impacts and trends. This should investigate changes in or due to sewage, agrochemicals, agro-industrial effluents and sediment loads.

S6.7 Economics

i. There is a lack of reliable data on flood damage, from which to estimate the benefits from the structural and non-structural measures to reduce damages in high floods. Research is needed to provide a comprehensive data set and methodology which could be used in planning and appraising interventions by FAP and non-FAP projects. This should be part of a general strengthening of BWDB's project appraisal and evaluation capability.

S6.8 Evaluation Methodologies

It will be increasingly difficult in future to apply the control area methodology for evaluation of FCD projects, and guidelines for a longitudinal methodology, including specification of the necessary baseline surveys, need to be developed. This should be done as part of a major strengthening of BWDB's monitoring and evaluation institutions to enable them to specify and supervise studies over a long time-span.

S7 METHODOLOGIES FOR IMPACT EVALUATION

S7.1 Timescales for Evaluation Studies

i. The fieldwork for both RRAs and PIEs was completed approximately to the original schedule for FAP 12, despite being largely undertaken during the monsoon and flood season. The original study timetable, however, allowed far too little time for analysing and reporting the 17 individual project studies undertaken. Future studies of FCD/I projects should allow a minimum of three weeks per project for RRAs, and six weeks per project for PIEs, for these tasks, plus adequate time for survey and questionnaire design.

S7.2 Rapid Rural Appraisals

i. Rapid Rural Appraisal proved a viable technique for evaluation of FCD/I projects, with sufficient scope for quantification of the main agricultural impact indicators to permit broad estimates of economic returns. RRA teams must however be selected very carefully. When used for comprehensive multi-disciplinary evaluations the technique is not transferrable to junior or non-professional staff, and even senior and well-qualified staff may lack the necessary capacity for inter-disciplinary synthesis. Precautions against introducing locational, socio-economic, seasonal and professional biases into RRA data must be implemented and kept constantly under review if results are to be useful.

ii. The RRAs used comparison over time to assess project impacts. While this has yielded consistent and convincing results, the use of control areas would probably have been beneficial as an aid to avoiding incorrect attribution of changes to project influence. However, finding control areas for RRAs is likely to be difficult in many areas, and fieldwork time would be substantially increased.

S7.3 Project Impact Evaluations

i. The core of the PIEs was a probability sample of agricultural and farm labour households selected by a two-stage design using mouzas (revenue villages) as the first stage. It proved possible to use the local government tax assessment lists for the mouzas, updated with local assistance, as household sample frames, and this approach is recommended for sample surveys where time does not permit the conduct of household listing censuses.

ii. Measurement of project impacts was by comparison with a control area, but in several cases it was found difficult to identify a good control, due to the widespread coverage of existing FCD/I projects, and controls selected primarily for comparability of agricultural characteristics were not always ideal for assessing other impacts. It is likely that in future evaluations of FCD/I projects, greater reliance will have to be placed on comparisons over time. This will require well-designed baseline surveys conducted in advance of project implementation, which in turn will require substantial strengthening of evaluation institutions in Bangladesh. It is recommended that BWDB's monitoring and evaluation institutions be strengthened to help them carry out this role.

S7.4 Comparability of RRA and PIE Results

The RRAs and PIEs for the five projects studied by both methods are in substantial agreement regarding the agricultural performance of the projects. Exceptions were in Kurigram South, where the PIE and RRA findings on adoption of HYV paddy differed considerably, and in Kolabashukhali, where the PIE found productivity benefits on land cropped pre-project, as well as the extension of cropped area detected by the RRA. The latter in fact would not have been detected by the PIE, pointing to the value of a diagnostic RRA in advance of a formal survey of PIE type.

In the case of the two PIE projects for which EIRR estimates were also made on the basis of RRA data, the estimates from the two methods were quite close. For Meghna-Dhonagoda, RRA gave an EIRR of 5 per cent, compared with 7 per cent from the PIE, while for Kolabashukhali the RRA gave an EIRR of 17 per cent, compared with 25 per cent from the PIE.

PIEs proved to be superior to RRAs for investigation of distributional effects of projects, since RRA group interviews tend to mask the range of variation present. Differential gender impacts were assessed in both RRA and PIE by using separate interviews conducted by female staff, but again it is likely that the one-to-one PIE interviews detected differences between women (as opposed to differences between women and men) better than RRA group interviews.

CONTENTS

TABLES

Figures

Abbreviations, Glossary & Equivalents

AAM	Agricultural Assessment Matrix
AED	Agroecological Division
AEU	Agroecological Unit
BADC	Bangladesh Agricultural Development Corporation
BBS	Bangladesh Bureau of Statistics
BCR	Benefit Cost Ratio
beel	shallow water body
BETS	Bangladesh Engineering and Technical Services
BIDS	Bangladesh Institute of Development Studies
BNC	Bangladesh National Consultants
BRE	Brahmaputra Right Embankment
bund	Earthen embankment
BUP	Bangladesh Unnayan Parishad
BWDB	Bangladesh Water Development Board
C/S	Country Side
chhatak	290 - 350 grammes
CIP	Chandpur Irrigation Project
CIRDAP	Centre for Integrated Rural Development in Asia and the Pacific
DSSTW	Deep Set Shallow Tubewell
DTW	Deep tube-well (with positive displacement pump)
DOF	Department of Fisheries
DAE	Directorate of Agricultural Extension
DAU	Draught Animal Units
dheki	wooden grain husking equipment
DU	University of Dhaka
EIP	Early Implementation Project(s)
EIRR	Economic Internal Rate of Return
ESL	Engineering Science Limited
FAP	Flood Action Plan
FAO	Food and Agriculture Organisation (of the United Nations)
FCD/I	FCD with or without Irrigation
ft	Feet
FCD	Flood Control and Drainage
FCDI	Flood Control Drainage and Irrigation
FPCO	Flood Plan Coordination Organisation of the Ministry of Irrigation, Water Development & Flood Control
FFW	Food For Work
ha	Hectare (2.47 acre)
haor	saucer-like depression, deeply flooded in monsoon (esp. in NE Bangladesh)
HTS	Hunting Technical Services Limited
HYV	High Yielding Variety
IBRD	International Bank for Reconstruction and Development (World Bank)
IDA	International Development Association (World Bank)
JICA	Japan International Cooperation Agency
KBK	Kolabashukhali Project
kaccha	earthen (of structures); impermanent
khal	Natural channel/minor river/tidal creek
khalashi	'Cleaner' (actually guard/operator) of regulator or sluice
khana	Household (defined as persons who normally eat together)

kharif	monsoon cropping season
khas	Government owned
km	Kilometer
LGEB	Local Government Engineering Bureau
LLP	Low Lift Pump
md	maund (37.3 kg.)
MPO	Master Plan Organisation of the Ministry of Irrigation, Water Development & Flood Control
MDIP	Meghna-Dhonagoda Irrigation Project
mt	metric tonne (1,000 kg., 2,204 lb.)
NMIDP	National Minor Irrigation Development Project
NPV	Net Present Value (of discounted cash flow)
NGO	Non-governmental Organisation
O&M	Operation and Maintenance
ODA	United Kingdom Overseas Development Administration
PPS	Probability Proportional to Size (sampling)
PEP	Production Employment Programme (of BRDB, q.v.)
PCR	Project Completion Report
PIE	Project Impact Evaluation
PP	Project Proforma
pucca	brick constructed (of structures); permanent
rabi	winter cropping season
RRA	Rapid Rural Appraisal
RHD	Roads and Highways Department
SCF	Specific Conversion Factor
STW	Shallow tube-well (with suction pump)
SRS	Simple Random Sampling
SPSS	Statistical Package for Social Sciences
TOR	Terms of Reference

The Bengali Calendar

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

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

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1 INTRODUCTION

1.1 GENERAL

Hunting Technical Services Limited (HTS) was engaged by the United Kingdom Overseas Development Administration (ODA) in 1990 to provide consultancy services to the Government of Bangladesh for Components 12 (FCD/I Agricultural Study) and 13 (Operation and Maintenance Study) of the Flood Action Plan (FAP). Support to these two FAP components was also provided by the Japanese International Cooperation Agency (JICA), which contracted Sanyu Consultants Inc. to provide consultancy support.

The Bangladesh Institute of Development Studies (BIDS) provided joint technical direction of the FAP 12 study, and fielded senior and junior specialists in seven professional disciplines. Technoconsult International Limited, a Bangladesh-based consultancy, provided senior and junior specialists in the engineering and rural institutions disciplines.

1.2 STUDY OBJECTIVES

The full Terms of Reference for the FAP 12 study are presented in Appendix A. The objectives of the study are to:

- assess the agricultural, economic, social and environmental impacts of FCD and FCDI projects and the extent to which technical and other objectives have been achieved;

- identify constraints to effective project management and to recommend ways in which project design, operation and maintenance can be improved to increase overall production;

- develop guidelines and criteria to be used in the planning, design, implementation, operation and maintenance and evaluation of projects under the Action Plan.

The achievement of these objectives has involved a comprehensive review of completed FCD and FCDI projects. This has involved both Rapid Project Evaluations (often termed Rapid Rural Appraisals or RRAs) and full Project Impact Evaluations (PIE). The overall aim of the study has been to assess the effectiveness of investment in the sector, to learn from previous experience in the planning, design, implementation and operation and maintenance of projects, and to provide an input to the planning of water management under the Flood Action Plan.

1.3 THE STUDY

The FAP 12 study was implemented over a fourteen month period, commencing in January 1991. Major study activities included reviews of previous evaluations of over sixty completed FCD/I projects, Rapid Rural Appraisals of seventeen projects, and detailed Project Impact Evaluations of five projects.

The FAP 12 team presented three workshops during their study, on Study Methodology, on the results of the RRAs, and on the results of the PIEs. Individual study reports were produced on each of the projects examined, and special reports were produced on Study Methodology and on the results of the RRAs (see flyleaf for full publications list).

1.4 ROLE OF THE REPORT

This Final Report summarises the overall results, conclusions and recommendations of the FAP 12 study.

Chapter 2 presents the key features of the Study Methodology. A comprehensive review of the methodology used will be found in the Methodology Report (HTS, September 1991).

Chapter 3 presents the study conclusions on the impacts of FCD/I projects, and on the major constraints limiting achievement of their objectives. This chapter synthesises much of the information that is provided in detail in the seventeen individual RRA and PIE reports, and integrates this into the broader picture provided by previous evaluations of FCD/I projects.

In Chapter 4 the study recommendations for planning, design, implementation, operation and maintenance of FCD/I projects are presented. These are followed by recommendations for further investigations, with particular reference to possible areas for action by other FAP components. Finally this chapter presents recommendations for methodologies to be used in future FCD/I evaluations in Bangladesh, in the light of FAP 12 experience.

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2 METHODOLOGY

2.1 PAST EVALUATIONS OF FCD/I PROJECTS

Table 2.1 lists over sixty FCD/I projects which have been the subject of post-completion evaluations during the past twenty years. Fifteen of these projects have been evaluated by two or more separate agencies. The table excludes projects which have irrigation, but no FCD, components, and it excludes projects for which Project Completion Reports (PCR) appear to have been prepared without field verification of project impact.

The earliest FCD/I evaluation identified was carried out in 1973 by BWDB, to review the Dhaka-Narayanganj-Demra Flood Control and Irrigation Project. This evaluation was updated in 1984.

Most of the subsequent project evaluations were carried out in the course of eight groups of studies:

- four of these were evaluations of EIP projects, in 1977 and 1980 by Md. Ali Akbar of Rajshahi University (Md. Ali Akbar, 1977 and 1980), in 1984 by M. Mosleh Uddin and A. Rob Khan of the University of Dhaka (Mosleh Uddin et al, 1984) and in 1988 by two Consultancy Companies (BUP, 1988 and BETS, 1988);

- three evaluations were carried out in 1986 of large projects implemented under IDA credit 864-BD (ESL 1986a and 1986b, Dhaka University, 1986);

- in 1987 another local Consultancy evaluated ten Small Scale Drainage and Flood Control Sub-projects implemented by BWDB under IDA credit 955-BD (BNC,1987);

- in 1988 three evaluations were carried out of large projects implemented under the Drainage and Flood Control II Project, IDA Credit 1184-BD (BETS, 1988a);

- in 1990 eight FCD/I projects were evaluated by the Master Plan Organisation as part of the National Water Plan Project - Phase II (MPO, 1991).

The remaining evaluations are very diverse, and vary from the very thorough, for example that of the Chandpur Irrigation Project (Thompson, 1990), to the rather superficial.

In the Methodology Report (HTS, September 1991), the methodological approaches used by past evaluations, and their strengths and weaknesses, are discussed in detail. The following conclusions are reached:

- the coverage, formats and methodologies used vary greatly. Many of the evaluations concentrate on agro-socio-economic impact, rather than any evaluation of the physical completion or state of the engineering works, and most fail to evaluate the hydrological impact of the engineering interventions;

Table 2.1 FCD/I Projects That Have Been Evaluated

Ser. No.	Project Name	EIP 1977	EIP 1980	EIP 1984	EIP 1988 Reconn.	EIP 1988 Detailed	MPO 1991	BWDB 1987	DFC-1 1989	DFC-II 1988	Other (No)	Brief Reference
1	Angarali Haor				XXXXX	XXXXX						
2	Baramanikdi SP										1	Technoconsult, 1990
3	Batkazal Khal Re-excavation	XXXXX	XXXXX									
4	Bhedra Beel				XXXXX	XXXXX						
5	Bhitabari-Damosh				XXXXX	XXXXX	XXXXX					
6	Bhola Irrigation										1	Sajjad Zohir, 1991
7	Bhola Island (West and South)							XXXXX				
8	Bhutiar Beel										1	BWDB, 1983
9	Brahmaputra RBE								XXXXX			
10	Chakamaya-Panchakuralia		XXXXX	XXXXX								
11	Chalan Beel Polder D						XXXXX			XXXXX		
12	Chandana Barasia	XXXXX										
13	Chandpur FCDI										3	Thompson, 1989; BUP, 1982; BWDB, 1979
14	Char Faizuddin				XXXXX							
15	Chenchuri Beel								XXXXX			
16	Damrir Haor				XXXXX							
17	Dhaka-Nganj-Demra IFP										2	BWDB, 1973; BWDB, 1984
18	Dhurung Khal							XXXXX				
19	Faliar Beel			XXXXX								
20	Gangrail Closure (Polder 17/2)				XXXXX							
21	GK Phase I				XXXXX							
22	Hail Haor									XXXXX		
23	Harihar River Excavation							XXXXX				
24	Hizla Embankment	XXXXX	XXXXX									
25	Jamuna Khal				XXXXX							
26	Kalaiya-Nehalganj				XXXXX							
27	Karnafuli IP										1	Sarm Associate, 1986
28	Karnahar Barabeel Embankment	XXXXX	XXXXX									
29	Kata Khal - Dublakuri				XXXXX							
30	Kolabashukhali								XXXXX			
31	Lohagara Embankment		XXXXX									
32	Manu River						XXXXX					
33	Mashajan-Lauhajang				XXXXX	XXXXX						
34	Mondakini Khal ISP							XXXXX				
35	Mrigi Khal SP							XXXXX				
36	Muhuri IP						XXXXX				1	FAO/BWDB
37	Nurunia Khal							XXXXX				
38	Patthakali Konai Beel		XXXXX								1	MPO/Harza, 1985
39	Polder 27/2	XXXXX	XXXXX		XXXXX							
40	Polder 34/3			XXXXX								
41	Polder 35/1 SP							XXXXX				
42	Polder 35/3				XXXXX	XXXXX						
43	Polder 39/1										1	BWDB 1991
44	Polder 42										1	BWDB 1966
45	Polder 46										1	BWDB 1966
46	Polder 47										1	BWDB 1966
47	Polder 48 SP							XXXXX			1	BWDB 1987
48	Polder 55/1						XXXXX					
49	Polder 65/A-3				XXXXX	XXXXX						
50	Polder 66/3				XXXXX							
51	Raktadaha-Lohachura			XXXXX			XXXXX					
52	Rauha-Bakchari			XXXXX								
53	Roachala Khal Re-excavation	XXXXX	XXXXX	XXXXX								
54	Sati Nadi			XXXXX								
55	Satla Bagda (Polders 1&2)									XXXXX		
56	Satla Bagda (Polder 3)		XXXXX	XXXXX								
57	Shanir Haor						XXXXX	XXXXX				
58	Shangair Haor			XXXXX								
59	Singua River Re-excavation	XXXXX										
60	Someshpur Khal		XXXXX									
61	Tala Thana			XXXXX								
62	Teesta Right Bank Embankment				XXXXX							
63	Tulshiganga River						XXXXX					
Totals		7	10	10	16	6	8	10	3	3	16	

Notes
EIP, 1977 and 1980 - projects reviewed by Md. Ali Akbar for EIP
EIP, 1984 = Projects reviewed by M. Mosleh Uddin et al for EIP
EIP Reconn. = Study of EIP project crried out at Reconnaissance level - see BUP, 1988 and BETS, 1988
EIP Detail = EIP project additionally studied at detailed level, see BUP, 1988 and BETS, 1988
MPO, 1991 = Project covered by Harza et al for MPO, 1991
BWDB, 1987 = Project covered by BNC for BWDB - see BNC, 1987
DFC-1, 1989 = Project evaluated for the Completion Report on DFC-1, FAO, 1989; ESL, 1986; DU, 1986
DFC-II, 1988 = Project evaluated for DFC-II - see BETS, 1988a
IP = Irrigation Project ISP = Irrigation Sub-project IFP = Irrigation & Flood Control Project

Source: Consultants

- the three most thorough evaluation studies are those of the Chandpur Irrigation Project (an FCD/I project), by Bangladesh Unnayan Parishad (BUP, 1982) and by Thompson (Thompson, 1990) and that of the Bhola Irrigation Project (a coastal embankment project) by Sajjad Zohir (Zohir, 1991);

- many of the other studies suffered serious methodological weaknesses, related to poor statistical procedures, poor analytical techniques, apparent inadequate appreciation of the parameters relevant to FCD/I impacts, neglect of possible impacts, timing of evaluations and reporting on methodological techniques.

The weaknesses identified did not, naturally, apply to all evaluations, but in some cases many were present. As a result caution has to be used in utilising the results of previous evaluations.

The FAP 12 team has examined the results of these previous evaluations, bearing their strengths and weaknesses in mind, and they are discussed and compared with FAP 12 conclusions in Chapter 3.

2.2 SELECTION OF PROJECTS FOR FAP 12 EVALUATIONS

The existence of previous evaluations was only one of the factors that contributed to the process of selecting projects to be evaluated by FAP 12. The Terms of Reference required the projects selected to be "representative of the types of FCD/I projects undertaken in Bangladesh" and to include projects from the North-West and North-Central regions.

The Terms of Reference required FAP 12 to carry out Rapid Rural Appraisals (RRA) of 12 completed projects, and detailed Project Impact Evaluations (PIE) of a further 6 projects. Twelve completed projects were selected for RRA, and in addition all the PIE projects were also initially examined using RRA techniques.

The original technical proposal envisaged each PIE would require about 210 interviews, a total of 1260. Subsequently FAP 12 were requested to add additional categories for supplementary interviews, and a detailed examination of sampling procedures indicated that it would be necessary to increase the sample size for the main household survey in order to achieve target levels of statistical confidence in the results. As this substantially increased the number of interviews per PIE, FAP 12, with the agreement of FPCO, reduced the number of PIE projects to 5, but carried out over 350 interviews at each - increasing the total number of interviews from 1260 to 1825.

The actual process of project selection was implemented in close liaison with FPCO and those Regional studies which had mobilised and followed a logical sequence. Full details of the process are given in the FAP 12 Methodology Report.

Initially a comprehensive list of all FCD and FCDI projects was drawn up. This excluded projects located south-east of the Feni River, as these are outside the FAP area. All projects that were not understood to have been completed by 1988, at the latest, were then excluded from selection, in order to avoid attempts to evaluate incomplete or only recently completed projects, where project impacts would not yet be detectable. The shortlist derived included 84 of the original list of 224 projects.

An analysis was then made of the overall distribution in Bangladesh of flood protected area by project type and by FAP area. This gave a broad indication of the distribution of projects that would reflect the relative importance of the different categories - for example as the North-West region has 37 per cent of the flood protected area it should receive more attention than the North-Central region, with only 1.5 per cent of the flood protected area.

The 84 projects were then divided into sub-groups by area and project type. It was agreed that where possible the PIE studies should select larger projects (protecting 15000 ha. or more), which had not previously been subject to a detailed post-evaluation and which offered potential control areas. Very few projects met these conditions, and the final selection was made from these few following discussions with FPCO and relevant FAP Regional Study teams, and in three cases (Kurigram South, Chalan Beel Polder D and Kolabashukhali), following a field reconnaissance visit to evaluate alternative possibilities.

In order to select the remaining projects for RRA the information on distribution by type and area was used to determine how many projects should be selected from each sub-group. The remaining unselected projects were screened to exclude those known on the available information to be over 15000 ha. in area, which were considered to require too long for effective RRA review. The remainder were then listed alphabetically by sub-group, and if their number exceeded the allocation a random selection was then made (using random number tables). In each case second and third choices were also noted, in case the first choice project proved unsuitable. In three cases this proved to be the case when the first choice projects were found, for varying reasons, to be unsuitable for study. In one case (Nagor River) the selected project was found to be just over 15000 ha. on more detailed study.

The 17 selected projects, and some of their key features, are listed in Table S1 in the Summary of this report, and their geographical distribution is illustrated in Figure S1. The projects provide a reasonable representation of the distribution of projects by region and by type, except that polders in the coastal cyclone zone were deliberately excluded, as these are the subject of special study under FAP 7, the Cyclone Protection Project. Table 2.2 shows the distribution of projects by FAP region and by type.

Table 2.2 Selected Projects by Project Type and FAP Region

Project Type	No. of Projects Selected in FAP Region						
	NW	NC	NE	SE	SC	SW	Total
FCDI	1	1		1			3
FCD Embankment on Main River	3						3
FCD (not Main River)	2	1			1	1	5
Submersible Embankment			2				2
Flash Flood River (canalised by embankments)			1	1			2
FCD Semi-saline Polders (Khulna area)						2	2
Total	6	2	3	2	1	3	17

Source: FAP 12 Consultants

During the process of project selection various other points were also taken into consideration:

- it was noted that FCD/I projects vary from very small (gross flood protected area under 1000 ha.) to very large (over 50000 ha.). The final selection included two of the very large projects, but was mainly focused on the more numerous projects in the 2000 ha. to 10000 ha. range;

- it was considered that if a project had been completed for more than fifteen years it would be difficult to obtain data on pre-project conditions, or to extrapolate a "without project" scenario. Table S1 shows that, with the exception of the Brahmaputra Right Embankment (BRE), this condition was adhered to;

- the country-wide variations in systems of farming were noted. These were adequately reflected in the geographical distribution of selected projects (Figure S1);

- the range of donors who supported FCD/I interventions is considerable. Table S1 indicates that projects assisted by all the major sector donors (World Bank, Asian Development Bank, World Food Programme and the Governments of the Netherlands and Sweden, through EIP) are represented;

- it was considered that some of the selected projects should be known to have adverse impacts on fisheries, or conflicts in management such as those between shrimp farmers and cultivators, as these issues had been identified as topics of special concern for FAP 12. Ultimately several of the selected projects proved to demonstrate such features.

Overall, therefore, the seventeen projects selected for RRA and PIE study do represent all the key features of FCD/I interventions in Bangladesh, and can be expected to display much of the diversity present.

2.3 RAPID RURAL APPRAISALS

2.3.1 Characteristics of RRA

The Rapid Rural Appraisal approach to data collection grew up in the 1970s out of dissatisfaction with the time and cost requirements of formal sample surveys; the approach has been well described in Chambers (1983). While RRA has been used previously for study of FCD/I projects in Bangladesh, notably in the evaluation of EIP projects (see, e.g., Nabiul Islam 1988) and in the series of studies by MPO (MPO 1991), its use by FAP 12 is probably the largest implementation of the technique in Bangladesh so far. As such, FAP 12 can throw some light on the strengths and weaknesses of the technique, in addition to the primary target of data acquisition for ex post evaluation.

The core of the RRA approach is the collection of data by means of selective interviews and direct observations made over a relatively short period of time (typically less than two weeks, and sometimes less than one) by a multi-disciplinary team of well-qualified and experienced specialists who can come to informed judgements rapidly in the field. An and experienced specialists who can come to informed judgements rapidly in the field. An essential aspect of RRA is thorough study of existing data sources, before the field phase begins, in order to avoid unnecessary duplication of effort, and to guide the targeting of key issues in the field.

A key principle of RRA is the use of triangulation, the estimation of data from different sources of information and by different approaches. For example, evidence on changes in foodgrain output in a study area can be sought by direct interview of cultivators for crop yield and area data, by interview of female household members for changes in foodgrain availability in the household diet, by interview of traders for data on price changes, and from published and unpublished government data. All of these should be in agreement, and none should be accepted in isolation when alternative sources are available.

Well conducted RRAs are characterised by the care taken to avoid achieving speedy execution at the cost of biases in the data. Sources of bias FAP 12 found particularly likely to distort poorly implemented rapid appraisals of FCD/I projects include:

- locational bias - for example, interviewing/observing only along motorable roads, or failing to penetrate low-lying areas because of flooding;

- socio-economic bias - in the extreme, interviewing only the conspicuous and vociferous local notable, while failing to cover the socially and economically disadvantaged. The interviewing of women in rural Muslim societies presents particular problems which require specific remedies if project impact on half the population is not to be ignored;

- seasonal bias - in Bangladesh the same area routinely presents a quite different appearance at different times of the year, and conclusions based on a short visit may be seriously misleading if precautions are not taken to triangulate direct observation with interview data on a longer time-frame;

- professional bias - while the ideal RRA team member would have an understanding of the interaction of all the disciplines required for evaluation of a given project, in practice precautions need to be taken to cross-check the findings and recommendations of different disciplines (for example, verifying that a livestock specialist's findings on fodder production are compatible with the agriculturalist's estimates of crop areas and the economist's estimates of costs and returns).

Not all of the sources of bias could be satisfactorily combatted within the constraints of the FAP 12 timetable and Terms of Reference. The measures taken, and the success achieved, are noted below.

2.3.2 Projects Selected for RRA Study

As noted in Section 2.2, FAP 12's ToR specified examination of 12 projects by RRA. In addition the 5 projects selected for PIE were also the subjects of preliminary RRAs. These pre-PIE RRAs were intended to fulfil the threefold objectives of familiarising team members with RRA techniques, providing a reconnaissance of the PIE areas as an aid to PIE survey design, and providing a basis for methodological comparison between the RRA and PIE techniques.

As shown in Table 2.2, the projects selected for survey by RRA only are generally of moderate size, only the Nagor River Project exceeding 15,000 ha.. This was the result of a conscious decision to concentrate PIE resources on larger projects, which is considered to have been well justified by the better coverage obtainable on smaller projects within the constraints of FAP 12's timetable. The Brahmaputra Right Embankment Project presented particular problems, in that its size and diversity made its survey by PIE unattainable within the available resources. It was therefore covered by RRA of two sample sections of the BRE selected purposively in discussion with FPCO, FAP 1 (the Brahmaputra Right Embankment Strengthening Study), and FAP 2 (the North-West Regional Study).

2.3.3 RRA Team Composition

The main programme of RRAs was executed by three field teams operating in parallel. The team leaders were agricultural economists, economists or rural sociologists with economic training, and the teams normally included an agriculturalist, a civil engineer, a rural institutions specialist and a female women's issues specialist. FAP 12 had two fisheries specialists, which was sufficient to assure coverage by this key discipline of projects where fisheries were a major issue. For other projects, team members of other disciplines covered fishery impacts, and this approach was also followed for livestock and environmental impacts where FAP 12 had insufficient specialists to staff three teams simultaneously. Nutritional impacts were covered by the female team members, who were able to interview female respondents on this issue. A typical field team had a strength of six or seven. Team membership was systematically rotated as part of a series of measures aimed at containing professional bias (see 2.3.1 above).

Participation in RRA teams was invited from the headquarters of BWDB, the Department of Fisheries and other organisations concerned in FCD/I development. Several such members, notably from BWDB, participated on an occasional basis, but it was found that while their involvement often contributed useful insights, it was difficult to integrate them into the full RRA cycle all the way through to report production. Mention should also be made of the local staff of BWDB, DOF and other agencies in the project areas, several of whom accompanied FAP 12 staff on field visits and whose assistance often proved valuable.

A particular problem was posed by the expatriate staff members of FAP 12, all of whom participated actively throughout the RRAs, but only one of whom spoke Bengali. While the breadth of experience which the expatriate staff brought to the RRAs amply justified their presence, and their contribution was essential to ensuring satisfactory disciplinary coverage, most of them had to be counterparted by a local professional of similar discipline. This constrained the flexibility of the field teams, and caused interviews to be protracted due to translation requirements.

2.3.4 The RRA Cycle

The main RRA programme was conducted from mid-April to mid-July 1991. The three field teams operated on a 3-week cycle, of which the first week was spent acquiring and assimilating documentary data (to the variable extent that such data were available in Dhaka), the second was spent in the project area, and the third was devoted to writing up. While the length of the cycle was dictated by FAP 12's timetable, and no longer period could have been accommodated within the original study schedule, the time allowed for reporting was found to be entirely inadequate. Team leaders were responsible for report editing, and FAP 12 had enough potential leaders to permit at least one to be 'out of field' during any given RRA cycle, but these staff had other commitments (including setting up and overseeing the PIE surveys from May onwards). Consequently, individual RRA reports were still being finalised several months after the scheduled end of this phase of the study.

The field teams invariably met with local BWDB staff early in the field phase of the cycle for discussion with the personnel directly responsible for the project under study, and to obtain documents not available in Dhaka. Not infrequently, however, key documents were unavailable either in Dhaka or on site, and a lesson from FAP 12's experience is the need for a systematic and comprehensive approach to preservation of project documents. Also at an early stage in the field phase the teams invariably met with the officials of the Upazila(s) covering the project area. Discussions were held with the Upazila Chairman, the Upazila Nirbahi Officer and the Upazila staff of the line technical departments and agencies; a typical list would include the Upazila Agricultural Officer, Fisheries Officer, Livestock Officer, Statistics Officer, Cooperatives Officer, Food Officer, and Engineer, and the staff of the local BADC office and the local Grameen Bank office. Where NGOs were active in the area their staff were also interviewed for information on their activities and also for their views as informed respondents on trends in the project area. Interviews and discussions with BWDB, Upazila officials and NGOs typically required 1 to 2 days to complete.

2.3.5 Field Techniques

The remainder of the field phase of the RRA cycle was occupied by transects through the project area, with observations along the route and group interviews at locations representative of all land levels in the project and of the range of accessibility from urban centres and main communications axes. Movement within the project area was by the fastest available means, in order to conserve time, subject to avoiding locational biases - by jeep where possible, by mini-taxi, rickshaw and boat as appropriate and available, and almost invariably with considerable distances on foot, wading where necessary.

Transects and interviews were conducted by sub-teams of 2-3 members, the full team being too inflexible and intrusive for the purpose. Initially the membership of sub-teams was rotated to minimise professional bias, but it was found that some disciplines had conflicting fieldwork requirements, while others were complementary, and sub-team membership tended to stabilise on this basis. For example, engineers and rural institutions specialists, who had a common interest in the project structures and the persons and groups operating and maintaining them, tended to work together. Agriculturalists, agricultural economists and related disciplines, on the other hand, were more interested in the catchment or command areas of the structures than the vicinity of the structures themselves. The requirements of the fishery specialists in several cases made separate fieldwork necessary for them, due to the distinctive spatial and ethnic characteristics of the traditional Hindu fishing communities.

The limited time available for fieldwork in general prevented the conduct of formally pre-arranged group interviews. Most interviews were therefore with ad hoc groups of respondents in which the exchanges tended to be dominated by the socially and economically prominent. Efforts were made to reduce the resulting socio-economic biases, for example by interviewing day-labourers separately during their rest periods in the fields, but it is likely that some biases remain. The presence of female team members during the main programme of RRAs did however mean that gross gender bias was avoided. A typical sub-team for those RRAs consisted of an agricultural economist or rural sociologist, an agriculturalist and a women's issues specialist, and at each selected interview site the female team member would

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conduct a separate group interview with female residents to discuss project impact on women and on nutrition.

RRA has normally been considered to be a better approach for obtaining qualitative than quantitative data, and FAP 12 initially was not sanguine about the possibility of obtaining quantitative data on crop areas and outputs on which to base economic re-evaluation of the RRA projects. However, a simple matrix approach to assessment of crop areas by land level and season (described in the FAP 12 Methodology Report) was adopted on the suggestion of the FPCO Panel of Experts and found to yield satisfactory results. Farmers were generally able to provide basic data on yields and crop budgets on which to base output, cost and return calculations, though there is some danger that, due to the socio-economic bias in group interviews, the results reflect 'best local practice' rather than the average situation.

The RRAs, unlike the PIEs, did not use a control area approach for assessment of the 'without project' situation. To have done so would have almost doubled the time required per RRA and exceeded FAP 12's timetable constraints. However, it is considered that such an approach would have significantly strengthened the RRAs, though it should be noted that the problems of obtaining good controls (see 3.1.5 below) would have applied in many cases.

The field teams normally conducted an informal group discussion amongst themselves at the end of each day's work and this proved a fruitful source of cross-fertilisation of ideas on the individual project under study and on FCD/I concepts in general. In addition, at the end of the fieldwork phase of each RRA cycle each team held a consensus meeting to minimise professional biases before the start of writing up. At these meetings each of the specialists in turn offered their brief conclusions for consideration by the rest of the team, with the objective of detecting and removing inconsistencies before the start of writing up.

2.3.6 Capabilities and Limitations of RRA

RRA is expected to provide a faster, less resource demanding approach to appraisal of rural conditions, while avoiding the biases to which undisciplined rapid data collection is prone. Achievement of these objectives requires:

- good organisation and thorough advance planning, leading to disciplined data collection with clearly defined and standardised data targets;
- a genuinely interdisciplinary approach by all specialists involved. Such an approach is not guaranteed simply by assembling a team covering a variety of disciplines;
- careful triangulation of key data by drawing on all available sources and disciplines.

Overall, the FAP 12 RRAs are considered to have been successful in producing evaluations quickly, relatively cheaply and without major biases in the data. The FAP 12 experience does, however, indicate several areas in which future practitioners should be especially watchful:

- minimisation of socio-economic bias requires constant vigilance and may call for considerable diplomacy on the part of field staff if the views of groups normally occupying subordinate positions in rural society are to be obtained;

- minimisation of seasonal bias in a short RRA always requires a constructive effort by field staff to visualise conditions at other times of the year. Some mitigation of seasonal bias may be possible through repeat visits to the study area, but this approach cannot be carried far without sacrificing the RRA objective of rapid execution;

- quality of personnel is all-important. The breadth of experience and capacity for informed judgement required in RRA staff mean that the technique is **not** suitable for transfer to junior staff, while even well-qualified senior staff with long professional careers may lack the capacity for inter-disciplinary synthesis which is crucial for successful RRA.

2.4 PROJECT IMPACT EVALUATIONS

2.4.1 Characteristics of Project Impact Evaluation

The PIEs were based on the concept of measuring project impacts by comparison of the area affected by the project - the impacted area - with a control area judged to have had comparable conditions to those prevailing in the project area immediately before project implementation. Present conditions in the control area, including developments subsequent to project implementation, can thus be taken to represent the 'without project' situation. It should be noted that the impacted area includes both the areas nominally protected by the project and expected to receive its benefits, and adjacent unprotected areas which are unlikely to benefit but which may receive adverse impacts, for example as a result of raised water levels.

The control area approach is not without problems, since a good control should not only be unaffected by the project under study, but should also be unaffected by other subsequent projects. With the large number of FCD/I projects constructed in the 1980s this is an increasingly difficult condition to fulfil in many parts of Bangladesh. For example, the only available control area for the Kolabashukhali (KBK) PIE in the FAP South-West Region was the Buter Beel area immediately across the Chitra River. This was not entirely satisfactory, since parts of it have possibly been impacted by KBK, but no alternative was available and Buter Beel itself would not have been available a year later. The days of the control area approach are thus probably numbered, so far as evaluation of new FCD/I projects in Bangladesh is concerned. However, the alternative approach of time-series comparison requires that adequate baseline surveys should have been carried out immediately prior to project construction, which has seldom or never been done up to the present.

The core of the Project Impact Evaluations was a questionnaire survey of households, using formal probability sampling techniques for selection of the households in the main sample. The strength of such an approach, in contrast to RRA and all other informal and non-probability survey techniques, is that the results produced are capable of being interpreted with known quantified levels of precision and confidence; that is, they permit statements of the form of 'The mean yield of paddy in the impacted area is estimated with 95 per cent confidence to lie between 1.75 and 2.25 mt./ha.'.

It follows that, provided sample sizes have been set high enough to provide usefully narrow confidence limits, differences between areas and over time can likewise be asserted with a known level of accuracy. This accuracy is achieved at some cost, in terms of sample size and therefore of financial cost and time to execute and process the survey. However, it should be borne in mind that the apparent time and cost advantages of non-probability surveys also carry a cost, in the form of the unknown margin of error attached to the results.

The use of a questionnaire survey, while not inescapably associated with probability sampling, also has advantages over non-questionnaire methods such as RRA in terms of the level of detail which it is possible to achieve in the data collected, and in the scope for introducing cross-checks for data validity and avoidance of interview bias.

One potentially important limitation of a household based sample survey needs to be noted. This is, that the survey will not by itself detect changes in cultivable area, when the land which becomes newly available had no previous operating or owning household. This was the case in the Kolabashukhali Project, which reclaimed a significant area of previously unoccupied land. In such a case recourse must be had to data external to the household survey to determine the area added.

2.4.2 Probability Samples and Case Studies

Probability sampling was used for selection of the samples of cultivating households and of labouring households from which most of the key indicators of project impact are derived. However, probability sampling has characteristics which prevented its use for all aspects of PIE data collection. Probability sampling requires that survey respondents be selected from a sample frame (list of possible respondents) which includes as nearly as possible all members of the groups for which results are required; thus, for the sample of cultivating households, a list of all such households in the project (or at least, in subsections of the project themselves selected by probability sampling) was required. The approach used in compiling the sample frames is described in Section 2.4.3 below.

For certain groups, however, the compilation of an accurate list was not possible in the time available to FAP 12. This applied in particular to fishermen, who do not necessarily fish in their area of residence, and to traders and operators of other non-farm economic activities, who are in many cases likewise mobile. For these groups a case-study approach was used, that is, the administration of a questionnaire to respondents purposively selected as representative of the group under study. Case studies cannot support statistical analysis in the same way as a probability sample, but if carefully selected can at least provide insights into the economic and social mechanisms at work in a group.

Preferably, however, survey programmes should include sufficient time for compilation of sample frames for minority groups. In the case of fishermen, for example, this would entail extensive reconnaissance of the area (which could be undertaken as part of a preliminary RRA) to form a complete list of fishing villages, followed by use of taxation lists or conduct of a mini-census to obtain household lists for final-stage sampling.

2.4.3 Probability Sample Design

a) Sample Design

The sample design used for the PIEs has been described in detail in the FAP 12 Methodology Report and will only be summarised here. The design was 2-stage, to minimise the logistical problems of acquiring sample frames. The first stage sampling unit was the mouza or revenue village, the smallest administrative subdivision recognised in Bangladesh and one for which records of households are maintained for local taxation purposes. The second stage sampling unit was the household, separate samples being drawn for cultivating and labour households. Mouzas were selected with probability proportional to size (PPS, with size defined as number of households) and households within mouzas by simple random sampling (SRS). This design is self-weighting, that is, it permits direct grossing up from mean household results to project totals, using the number of households in the project as the multiplier.

b) Sample Frames

The sample frame for mouza selection was the Small Areas Atlas of Bangladesh, which lists mouzas with their number of households from the 1981 Census; unfortunately the 1991 Census, which was conducted shortly before the start of the PIE programme, had not been processed far enough to be used for this purpose. The sample frame for selection of households within mouzas was the list of household heads in each mouza maintained for tax purposes by the Union, the next higher administrative subdivision. The lists include all household heads, whether tax-payers or not, but were in some cases several years out of date. In all cases the lists were updated with the assistance of knowledgeable local informants to reflect changes due to deaths, migration and household fission, and at the same time occupational details were obtained for household heads as a guide to sampling cultivating and farm labour households.

It should be noted that use of the tax lists implies acceptance of the definition of a household used by the Union Parishad, which is that of a 'khana', persons who normally eat together. Comparison with other sources of household numbers, especially the 1983-84 Census of Agriculture, indicates that this definition does not always match that used for other statistical compilations, but the household numbers from tax lists are normally compatible with those from the 1981 Census. The alternative to using the tax lists, which is a mini-census of the selected mouzas, would have been too time-consuming to carry out within the FAP 12 timetable.

c) Multiplier for Project Level Estimates

Incompatibility with the 1983-84 Agricultural Census (the only official source for numbers of cultivating households) created problems in deriving a suitable multiplier for grossing up results to project level. The approach ultimately adopted was to generate an estimate of total number of cultivating households from the PIE data themselves, dividing the cultivable area (as defined in project documents) by the estimated mean area operated per household.

d) Sample Size

Sample size was set at 60 cultivating households in each analytical stratum (impacted/protected, impacted/unprotected, and control). This size is adequate, under expected levels of variance and intra-cluster correlation, to provide 75 per cent confidence in a two-tailed confidence interval equal to 10 per cent of the value of an estimated mean. The samples for the impacted/protected and impacted/unprotected strata were pooled, giving a total of 120 cultivating households, the intention being to permit post-stratification of the impacted area. In the event the number of unprotected households sampled was small in most projects, and with hindsight the sample might have been more equally divided between impacted/protected and control, with gains in precision for the control area.

The original intention was to use a case-study approach for assessment of project impacts on farm labour households, but this was changed to probability sampling when it became apparent that the compilation of sample frames for cultivators would also produce frames for labourers without additional resources. Sample size for farm labour households was set at 24 per analytical stratum (i.e. 48 in the combined impacted areas and 24 in the control). It was recognised that this would not give very precise estimates for such households, even though it was expected that such households would be less variable in their characteristics, but it was felt worthwhile to use a probability sample in view of the methodological value of variance estimates for future survey design.

To hold the adverse effects of intra-cluster correlation on sample efficiency to manageable proportions, the number of cultivating households sampled per cluster was set at 5, and of farm labour households at 2.

e) Interview of Female Respondents

Coverage of female respondents by PIE surveys was not specified in the FAP 12 ToR but was added during survey design after consultation with FPCO, the Panel of Experts and ODA. The additional survey resources required were minimised by drawing female respondents from the households drawn for other samples (whether probability or case study). Enumeration resources were insufficient to secure complete coverage, but it was possible to cover all case study households and approximately 50 per cent of cultivating and farm labour households with a women's interview.

f) Representativeness of Samples

As a check on the representativeness of the PIE samples, the characteristics of the sampled households in each PIE area have been compared with measures available from published BBS statistics for the same areas. Household size for farming households is generally somewhat larger than the mean for the relevant Zila, a not unexpected finding given that such households generally have more economic security and older heads than labour households. Labour household sizes generally correspond closely to the Zila average.

The sex ratios in the sample households accord with expectation, showing a majority of males (generally around 110 males per 100 females) in farm households. In labour households the sex ratio is lower, for some projects below 100, possibly reflecting the greater incidence of out-migration in these households. The PIE surveys attempted to include temporarily absent household members, but there is inevitably a risk of under-enumeration in such cases. In general, however, the PIE probability samples appear to reflect accurately the household characteristics of the areas sampled.

2.4.4 Field Procedures

a) Fieldwork Schedule

The PIE surveys were executed by a team of 15 enumerators (3 of whom were women) and four field supervisors (later increased to 6), between late May and the end of October 1991. Each PIE was executed in 3 weeks of field time, with one week out of field between PIEs for rest and recreation. To ensure that the enumerators were able to start promptly in each new area, an advance party of two to three supervisors under the supervision of a senior professional consultant travelled to the area a week in advance for collection of household sample frames and drawing of second-stage samples.

b) Field Team Organisation

Enumerators were normally formed into sub-teams of either two men or two men and one woman; the number of female enumerators was sufficient for them to be included in half of the sub-teams, and since the questionnaire administered to female respondents was considerably shorter than that for male respondents, one female enumerator was normally able to interview the female members of two households while her male colleagues were interviewing one household each. Consequently, as noted above, it was possible to administer the women's questionnaire to the female members of about half the households in the main probability samples. The field supervisors also administered a community-level questionnaire to the community leaders of the sampled mouzas.

2.4.5 Data Processing

a) Data Checking and Processing

Data were checked in the field by the field supervisors. Completed questionnaires were further checked on the return of the PIE field team to Dhaka before computer data entry. Data entry was carried out with the dBase III+ database package, and substantive processing of the data files (after checking for key-punching errors) was carried out with the SPSS (Statistical Package for the Social Sciences) data analysis package.

b) Statistical Procedures

A noteworthy feature, commonly ignored in survey data processing, is that all the proprietary statistical packages now available, including SPSS, use algorithms for variance estimation which assume the use of a single-stage simple random sample design. These algorithms are not applicable to 2-stage designs of the type usually adopted, as in FAP 12, for logistical reasons. Variance calculations using the correct algorithms were therefore carried out by secondary processing of SPSS or Dbase output, using a simple spreadsheet system developed in the Lotus 1-2-3 package. The variance algorithms used are given in Appendix P in Volume 4 of this report.

2.5 METHODOLOGIES FOR IMPACT EVALUATION

2.5.1 Methodology for Environmental Evaluation

A comprehensive account of the environmental methodology is provided in the FAP 12 Methodology Report. As the level of post-evaluation is much less detailed than full project environmental audit, an approach that has been termed here **preliminary environmental post-evaluation (PEP)** has been used.

The PEP adopts different time and spatial perspectives to those of the PIE socio-economic surveys. The latter compare the Project Area with a purposely selected Control Area for a specific crop year (Aus 1990 to Boro 1990/91 for all PIEs except Zilkar Haor, where the Boro 1989/90 - Aman 1990 year was used). This permits comparison of with- and without-project scenarios. The PEP, on the other hand, retains the before-and-after approach of the RRA studies, thus confining itself to the Project Area and any identified external areas affected by the Project. It then recognises different **agroecological divisions (AEDs)** within the Project Area, based initially on FAO (1988), and identifies the impacts within each[1]. 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 may not be identical, but are expected to complement each other.

In employing a before-and-after approach, the PEP assesses project impacts relative to what would have been the continuing pre-project trends, rather than to specific pre-project points in time. Thus although major environmental changes may have taken place in the Project Area, these may sometimes be primarily the result of trends occurring irrespective of the Project and generally receiving only minor and/or localised additional impacts from it. These may include the more obvious negative ecological impacts such as wetlands retreat and the decline of birds, fish and other wildlife; hence the often limited biotic impacts of projects.

It is also necessary to assess the impact of what the Project has achieved in practice, rather than the anticipated impact of what was planned. Drainage, for instance, has often not been as effective as intended, due to poor planning and design of structures, followed by poor operation and maintenance. Embankments may have failed, causing catastrophic flooding in some years, with major environmental impacts.

The initial screening-scoping during the RRA identifies many of the significant environmental issues and impacts. The PEP then 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;

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[1] In the FAP 12 Methodology Report AEDs were termed **agroecological units (AEU).**

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

- 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 in the PEP is achieved by considering each impact within each AEU or external impact area in turn and applying five **assessment factors**:

- magnitude (degree of impact);
- prevalence (extent);
- duration and/or frequency;
- risk of serious environmental damage;
- 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. In the external areas, **off-site impacts** are assessed. In study areas which form one of a group of similar projects within the same river basins, off-site impacts are assessed as the **cumulative** effects of the whole group of projects, to avoid the under-estimation of what collectively might be important environmental impacts.

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.

2.5.2 Methodology for Economic Reappraisal

Economic reappraisals have been conducted for all of the 17 projects studied by FAP 12. It was found possible from RRA data to quantify at least the agricultural impacts to a level permitting an approximate measurement of project cash flows, though the PIE surveys permitted estimates to be prepared in much greater detail and with much greater confidence in their representative nature. The preliminary RRAs of the five PIE projects were conducted partly as familiarisation exercises, and the impact data which they obtained are not in all cases comprehensive enough to permit an economic reappraisal, but a reappraisal, based on the RRA data, has been attempted in two cases (MDIP and KBK) for comparison with the results from PIE data for the same projects.

The economic reappraisals have been conducted on the lines laid down by the FPCO Guidelines on Project Appraisal (FPCO July 1991). In most cases, including all the reappraisals based on PIE data, the projects have been evaluated at constant mid-1991 prices, though in a few cases (notably including KBK) the reappraisal based on RRA data was conducted using a different base year for comparability with previous ex post appraisals conducted for PCRs. Standardisation of local cost and benefit streams to the selected base year has been carried out using the appropriate inflation indices published by the Bangladesh

Bureau of Statistics (BBS 1990, 1991) and foreign exchange costs have been standardised using the MUV deflator published by the World Bank.

Wherever possible construction and O&M costs have been taken from existing sources, mainly the PCRs prepared by BWDB or, in the case of the larger externally funded projects, by or on behalf of the international funding agencies. O&M costs and recent rehabilitation costs have been updated with data provided directly by the relevant BWDB O&M Circle. For a few of the RRA projects (e.g. Kahua-Muhuri) the construction cost data were so scanty that recourse was had to standard BWDB estimates of unit costs for the types of earthworks and structures included in the project, while in others (e.g. Sonamukhi-Banmander) there was no information on O&M costs and estimates were set in line with the known range for comparable projects from other RRAs and PIEs.

The dominant influence on project benefit streams in all cases is agricultural output, which was estimated from RRA and PIE data supplemented with published and unpublished secondary sources where these were available and believed to be reliable. While standard sources of input-output coefficients, such as (MPO 1987) were consulted, greater weight was normally given to direct survey findings, which are more up to date and location-specific. The same applies to prices, survey data being preferred (except in the case of clearly aberrant survey estimates) to sources such as (FPCO 1991). Fisheries outputs and costs of production could not be determined with such accuracy, and a methodology based on standard changes in productivity for different types of water body was developed. Other non-crop outputs, including livestock and non-farm production, with their costs of production, were estimated where sufficient data were available.

It was difficult to make estimates of the rate of take-up of project benefits or of the transition to with-project conditions. Ideally a transition from pre-Project to current without-Project (control area) conditions should be estimated and compared with the time series from pre-Project to current with-Project conditions for the impacted area. In practice, in most cases 'without-Project' conditions were compared to a linear growth to 'with project' conditions, although where more information on take-up rates was available, this was used.

The treatment of flood damage to crops in the with-project situation also proved difficult in the cases where it arose (see Thompson, 1990 for a discussion of the issues). In projects which have not suffered external flooding it was assumed that the yield estimates used reflected the average annual yield under the prevailing drainage conditions, while without project yields were adjusted to reflect the reported frequency and extent of flood damage. In some cases with-project average annual yields adjusted for flood damage could be estimated (Halir Haor). In other cases where crop damages were known to have occurred in peak floods such as 1988 (Katakhali Khal, MDIP) it has been possible to model the actual benefit/disbenefit flow up to the present, compared with the ideal flow had there been no failure. However, had these been greater than design standard events, the resulting judgement might have been excessively harsh, since the project planner cannot know when the embankment will be overtopped - it may be never, or at any stage in project life. However, since MDIP did not fail due to an over-design event, it seems fair to model the actual benefit flow.

Conversions from financial to economic prices have been made using the Specific Conversion Factors given in (FPCO 1991). In general little difficulty was experienced in breaking down project outputs and their production costs into reasonably homogeneous categories for application of SCFs, but it was found that available data on project construction costs (mainly BWDB and international donors' PCRs) were often too aggregated for SCFs to be realistically applied. In such cases breakdowns into homogeneous cost categories were made using standard cost compositions from MPO and BWDB sources.

Economic performance has been assessed in terms of three indicators: Economic Internal Rate of Return (EIRR); Benefit-Cost Ratio (BCR); and Net Present Value. Both BCR and NPV have been calculated at a 12 per cent discount rate, in line with (FPCO 1991), and the same rate (the assumed opportunity cost of capital) has been taken as the threshold for project economic viability. Since the estimates of project output, whether from RRA or PIE, are subject to a margin of error (see 2.4.1 above), the sensitivity of the performance indicators to varying levels of benefits, within the known range of confidence, has been tested. A noteworthy finding has been that in some cases (e.g. Chalan Beel D, Kurigram South) EIRR has be found to be very sensitive to changes in crop yield assumptions, with switching values within the expected margin of error of PIE yield estimates from sample survey.

3 THE IMPACT OF COMPLETED FCD/I PROJECTS

3.1 FACTORS LIMITING IMPACT EVALUATION

In the following sections numerous conclusions are presented relating to the impact of the FCD/I projects studied by the FAP 12 team. In general the trends observed are supported by a wide range of observations, and many have been previously identified by other evaluations. Nevertheless the FAP 12 team has been well aware of the limitations of impact evaluation for the reasons stated below.

3.1.1 Diversity

The diversity of FCD/I projects, and of their impacts, is such that almost any attempt at generalisation is likely to be misleading. In presenting this overview of conclusions from 17 studies it is inevitable that many statements have to be qualified, as there are exceptions within the 17 case studies to almost every broad trend or feature identified.

3.1.2 Complexity

Many FCD/I projects are remarkably complex, in terms of their hydrological features (their impacts on the depth, timing, location, speed, probability, and water quality of floods, for example), of their consequent agricultural impact and of their positive and negative impacts on a range of other activities, within and outside the protected areas.

On larger projects it was found difficult to fully quantify this complexity in the time available for Rapid Rural Appraisals, and even on smaller projects it was sometimes difficult to balance the diverse range of impacts (some of them inherently unquantifiable) in order to reach a clear positive or negative overall evaluation.

3.1.3 Separability of Impacts

It is not unusual in impact analysis to find that several different activities have proceeded simultaneously, and that it is difficult to identify the impact of one activity alone. In the case of FCD/I projects in Bangladesh, the analysis of FCD/I impacts is complicated by the recent widespread development of small scale irrigation, which has led to substantial changes in rabi season irrigation in both unprotected and flood protected areas. It was also found that it was difficult to distinguish the impacts of rural roads and of FCD/I embankments in promoting economic and social development.

3.1.4 Externalities

During most of the Rapid Rural Appraisals there was inadequate time to examine the possible impacts of FCD/I interventions outside or downstream of the protected area. During the PIEs, and in some of the RRAs, it was possible to explore these impacts and they were found to be significant in several cases. Where time was inadequate, the RRAs may have missed external impacts.

3.1.5 Control Areas

The PIE studies used control areas to identify what would have happened in the "without project" case. However, the control concept is borrowed from the natural sciences, and there is rarely, in any social science investigation, a "control" which is an exact replica of the "treatment" (in the PIEs, the project impacted area). In the case of the PIEs the identification of control areas posed particular problems, as there were relatively few nearby areas that did not benefit from some form of flood protection. However, correlation analysis of pre-project hydrological conditions in the project areas and their respective control areas (see Appendix G in Volume 3 of this report) indicates that the hydrological comparability of the controls was never less than good, and in some cases excellent. Since agriculture is so heavily influenced by hydrology in Bangladesh, this strengthens confidence that agricultural conditions were also comparable.

A further difficulty with the control areas was their inevitable selection on the basis of their agricultural similarity to the protected area. In some cases the control area was quite different from other points of view, such as fisheries, and could not be used for comparative analysis by these disciplines.

The RRA studies in general did not use control areas, mainly because of the short time available for fieldwork. While the same problems in identifying controls would probably have been encountered, some attempt to use them would probably have been beneficial.

3.1.6 The Timing of Evaluation

There are always difficulties in timing an evaluation. If it takes place too soon after project completion it is too early to identify impacts that take a few years to emerge. As FAP 12 only selected projects completed by 1988 this difficulty was mainly avoided. However some of the projects examined dated back many years, and some had been the subject of several interventions. In these cases there were considerable recall difficulties, when interviewees were asked to remember "before project" conditions ten or more years earlier.

A more complex "time" problem related to the period over which some projects were to be judged. Several had undergone considerable changes during their lifetimes - either a one to ten year period of "success" followed by persistent failure, or an initial disappointing period followed by rehabilitation, followed by relative success. The approach adopted was, wherever possible, to evaluate the entire project period, and to explore the implications of possible alternative histories (for example what would have happened if a project had been built to planned schedule, instead of over a 9 year period).

A final "time" related problem that the Rapid Rural Appraisals probably did not fully overcome is "season" bias. The RRAs took place between April and July 1991, from the early to mid monsoon period. Although the teams made every effort to find out what conditions were like throughout the year, their own observations naturally coloured their conclusions. For example, when an area was observed to be deeply underwater the RRA team was unable to credit local statements that there was usually a high kharif cropping intensity. Subsequently it emerged that this deep flooding had been a result of very heavy rain and drainage congestion, which did not persist, and the usual kharif cropping intensity was probably achieved. This again reflects the complexity of FCD/I conditions, and leads to the conclusion that a first step in improving on basic RRA analyses would involve multiple visits to each project, at different times of the year.

3.1.7 Quantification

Quantification of project impacts from Rapid Rural Appraisals was difficult, particularly on the larger projects. Secondary data were utilised wherever possible, but their reliability was sometimes in doubt, and in general the administrative areas on the basis of which data are compiled (Upazilas, Unions) do not coincide with project boundaries, so the data have to be treated with caution as guides to change within the project area. The Agricultural Assessment Matrix (AAM) approach was adopted to assist in quantifying new crop area data collected during the RRAs, but since RRA data do not conform to probability sampling conditions the margin of error of the resulting estimates is unknown.

3.1.8 Project Objectives

Assessment of project impact must start with an understanding of project objectives. These were often inadequately defined, making it impossible to compare planned and actual impacts. In particular the precise parameters of intended flood control (reduced flooding frequency, location, depth, etc.) were rarely defined.

3.1.9 Project Documentation

Some of the projects selected were very poorly documented. In some cases original feasibility studies, Project Proforma (PP) or designs could not be traced. In general it was not possible to locate as-built drawings, an essential requirement in the evaluation of engineering structures.

3.1.10 Confidence Limits and Economic Analyses

In the course of the economic analyses the teams tested, as is conventional, the sensitivity of their results to possible changes in the various parameters used. On several occasions similar features were noted:

- the results were not sensitive to plausible changes in the cost estimates, either for capital or O&M costs. In general, although some of the cost estimates have been based on weak data, more accurate figures would have made little difference to the results;

- the results were also not very sensitive to substantial changes in the estimates of fishery losses. Unless the figures generally used, which are based either on MPO guidelines or on field data where the latter is better, are more than double the correct figures, more accurate data would again not have substantially changed the conclusions;

- the results were, however, very sensitive to relatively small changes in yield estimates, particularly when one variety dominated the with or without project cropping pattern. In some cases a difference of less than 10 per cent in the estimated average annual yield of the main crop meant the difference between a zero and a 12 per cent economic internal rate of return (EIRR). RRA certainly could not have delivered a yield estimate at that level of accuracy, and even the PIE yields of major crops were expected to be accurate (with 75 per cent confidence) to between plus and minus 10 per cent of the mean figure used. Hence, the EIRR should be used extremely cautiously as a measure of project evaluation - and should never be taken on its own as the criterion for success or failure.

3.2 ENGINEERING PLANNING, DESIGN AND IMPLEMENTATION

3.2.1 Project Objectives

FCD/I projects are highly diverse, and this is clear from an initial analysis of their basic objectives. The projects selected for evaluation were intended to reflect this diversity and their intended hydrological impacts vary in location (inside and outside the protected area), in the form in which they affect flooding within the protected area (depth, timing, location, extent, frequency, sediment load, salinity) and in their achievement. In all the projects reviewed the major benefit of changed flooding, drainage and, where relevant, irrigation parameters, was expected to be agricultural.

The engineering designs used were intended to achieve certain standards of flood protection and drainage. The former were usually specified explicitly but in smaller projects the design standards justification for the drainage design was rarely documented.

Most of the FCD/I projects studied under FAP-12/13 were planned in the 1960s and 1970s. While assessing the planning, design and implementation standards of the projects, one should take into consideration the data and modelling limitations at that time. During the 1960s available hydrological data covered only a few years and there was little scope for regional hydrological studies.

The radical change in agriculture which occurred during the 1980s with the growth in groundwater irrigation could not have been predicted when the original project plans were made. However, many of the projects evaluated were either planned or re-appraised and completed in the 1980s and at that time planners should have taken into account improved hydrological data and changing agricultural trends.

Despite these adverse factors some of the projects studied appeared quite successful in fulfilling their primary objectives (Halir Haor, Kolabashukhali, Zilkar Haor). Some projects might in isolation have been successful but failed to take account of other FCD/I projects and regional hydrological changes (Nagor River Project, Brahmaputra Right Embankment).

3.2.2 Planning

a) Consultation

Project planning was generally carried out by consultants or BWDB with little or no collaboration with other relevant departments such as the Roads & Highways, Fisheries, Agriculture, Forest and Livestock Departments.

Generally there was no discussion with the intended beneficiaries at the planning stage and hence local needs and knowledge were not taken into account. In the few cases in which there was consultation at the planning stage projects were generally better conceived and their implementation and subsequent operation and maintenance were facilitated (Protappur, Zilkar Haor).

b) Hydrological Study

The planning of some of the projects studied appears to have been undertaken without the requisite hydrological studies. The lack of proper comprehensive hydrological surveys and of regional and project level modelling studies (where possible) has resulted in a series of post-project problems, such as:

i. frequent public cuts both by insiders and by outsiders (Chalan Beel Polder 'D', Nagor River Project);

ii. back flow in rivers & channels (Nagor River Project, Sakunia Beel Project, Sonamukhi-Banmander Beel Drainage Project);

iii. severe erosion (BRE, Kurigram, MDIP, Nagor River Project);

iv. drainage Congestion (Chalan Beel Polders); and

v. siltation (Polder 17/2; river beds in general).

A comprehensive hydrological study for the Chalan Beel and Nagor Basin areas in particular could have contributed to far more effective planning of these projects. Various studies of the Atrai and Nagor Basins predict a rise of about 2-3 m. in river water levels in the region after full confinement of the rivers by embankments. Fortunately the FAP now offers an opportunity to plan for and rationalise FCD measures at the Basin level.

Complete or partial closure of some existing rivers/channels passing through projects has caused severe hydrological effects creating disbenefited areas outside the projects and drainage congestion or damage to structures inside the projects (Kompo River in Chalan Beel Polder-D, Ratna River in Kurigram South). Such projects experience regular public cuts both by outsiders and by insiders.

The drainage congestion at Sonamukhi-Banmander Beel drainage project could not be successfully overcome as the huge inflow of flood water from Indian territory into the project area was apparently overlooked during the planning stages. To avoid similar failures the activities of the neighbouring country need to be considered when planning projects close to the border.

Embankment alignments sometimes do not appear to have been properly planned to avoid frequent construction of retired embankments. The set-back distance is a very important factor for ensuring that the design life of a project is achieved, but in some of the projects it was found to be almost zero along major portions of the embankment (Nagor River Project, Meghna-Dhonagoda, Chalan Beel Polder D, BRE, Kurigram). It was necessary to construct retired embankments at least twice before the completion of the Meghna Dhonagoda Project, and bank protection works are still under way there in 1991. In some cases, embankments were built on the active flood plain and erosion of the sandy material is inevitable (Kurigram South). The BRE has faced retirement as many as seven times at some locations.

c) Use of Infrastructure

The multiple uses of embankments have very rarely been taken into consideration at the planning stage. The most common secondary use of embankments is as roads (almost invariable), and they often make a significant contribution to economic development as a result. However this role is again generally ignored at the planning stage (the BRE is a notable exception) although it has significant implications both for design criteria and for subsequent operation and maintenance. Other uses of embankments include permanent and temporary housing (the BRE is often described as a linear housing estate), temporary refuge in times of flood, social forestry and even sweet potato seedbeds. Not all of these may always be appropriate, but a more realistic view of embankments' multiple functions should be taken at the planning stage. This would avert, for example, the situation in which structures are designed for water control but used partly (or even solely) as bridges.

A similar view needs to be taken in planning the location and specifications for borrow-pits, as these can often be subsequently used as fish-ponds. Borrowpits may be used as irrigation or drainage channels, or fish ponds could have been included in the original project concept. If the borrowpit is productive there may be fewer problems in land acquisition.

Absence of integrated fisheries development and flood control plans in FCD/I projects, especially in the haors, beels and coastal areas has created acute social conflicts between fishermen and farmers (Polder 17/2, Nagor River Project), which should have been solved at the planning stage, to avoid public cuts and O&M problems.

In Bangladesh, boat transport is the cheapest and most important transport mode in many areas but in all the projects except one this aspect was ignored. The Meghna-Dhonagoda feasibility studies recommended the provision of navigation locks, but these were deleted from the detailed design.

d) Changing Conditions

Due to rapid changes in cropping and land use patterns, the original scope of work fails to fulfil the present irrigation and drainage requirements of the prevailing crops in many projects. Regular co-ordination with the Agriculture Department could have addressed this either through revised operational procedures, or through modifications to the projects.

All the FCD/I projects, in general, have considered surface water irrigation and constructed a number of pipe irrigation inlets, flushing sluices, canals, and a few weirs, but overlooked the possibility of irrigation by ground water. As a result, the installation of STW/DTW has made the surface water irrigation system obsolete in some projects (Protappur Project)

Close co-ordination with the Upazilas can save a project from unwanted adversities. Many earth roads have been constructed under FFW programmes within the project areas without providing adequate drainage culverts, creating unnecessary drainage congestion and damaging crops. There is a need for active coordinated planning.

3.2.3 Design

The design of the embankments and structures of most of the projects were generally found to be sound, given the purposes that the planners had identified for these structures.

However, embankment design at MDIP was defective. The original proposal for the MDIP embankment was altered at the time of detailed design and the revised embankment section failed in two successive years due to insufficient earth section and piping below the embankment. Appropriate compaction of the embankment is a vital factor which the designer must specify to ensure the long life of the embankment.

a) Soil Investigations

Where designers had insufficient hydrological and subsoil data, designs were inevitably sometimes inappropriate, and the projects are now facing problems with defective structures and embankments. The embankment failures at MDIP were partly due to inadequate assessment of subsoil conditions, and in the same project the foundation of the Uddhamdi pump house settled and cracked for the same reason. In the Kolabashukhali Project, two regulators have settled and construction of a third (Bhombhag) has halted due to foundation problems.

b) Drainage

Many of the design problems observed related to drainage. Almost all the FCD projects studied are experiencing some congestion, and in 8 out of 17 it is moderate to severe (see Table 3.2). Unless pumped drainage is used, congestion is almost unavoidable in the common circumstances of high rainfall coinciding with high river stages. However, in many cases the problem has been accentuated by faulty hydrological assessment for structures and the absence of an adequate drainage network. The latter may be a planning, design or maintenance problem, but the former relates to design. For example at the Sonamukhi-Banmander project the design capacities of the 6 vent regulator at Shankarpur and of the 3 vent regulator at Rudrapur on the Betna River and the Daudkhali khal respectively were wholly inadequate for the huge volume of water to be discharged. As a result they are causing back flow for a long distance upstream.

In some projects a few structures (mainly flushing/drainage sluices) were located in inappropriate places and have subsequently been abandoned. In general much could be gained by local consultation at the design stage, in order to make maximum use of local knowledge about existing drainage features (KBK).

At least 8 of the 17 projects experience frequent public cuts (Table 3.2), made either by insiders trying to remedy inadequate drainage capacity, or (less frequently) by outsiders trying to dispose of water ponded against the outside of the embankment. These cuts are often so serious in their subsequent impact that they compromise the scheme's viability. In so far as they result from the non-existence or inadequate capacity of the drainage sluices, public cuts reflect design problems. However in other cases, as noted above, the original planning concept may have been at fault.

c) Structures

Regulator gates are leaking everywhere, as the rubber seals are either defective or absent. The wooden fall boards commonly used in small regulators are an O&M menace to any FCD/I project. In submersible embankment projects these are very difficult to operate and in all projects they are frequently stolen, damaged or washed away. On technical grounds their use should be avoided, except for the maintenance of regulators. However, for water retention under effective local management they may be viable. In many cases vertical lift gates are a more efficient solution, even if more expensive. In Protappur Irrigation Project most of the regulators could have been easily replaced by simple masonry weirs, and this would have reduced the cost of the project and subsequent operational hazards.

Some regulators/sluices designed for a single purpose (drainage or flushing) are being used both for drainage and flushing, causing damage to the structures (KBK). In some drainage-cum-flushing regulators two flap gates are used instead of a single vertical lift gate, causing more operational hazards.

3.2.4 Implementation

Most of the projects took longer to implement than the period specified and some were left incomplete for a long period. The construction of a small component, such as one or two regulators or closures, was sometimes left until much later, postponing all or most of the benefits, even after more than 80 per cent of the project cost had been disbursed (Polder 17/2). The reasons for such delays varied, and long periods required to resolve problems encountered often reflected poor original planning or design. In the meantime river courses and cropping patterns sometimes changed, yet the plans were not modified to reflect these changes.

Delay or lingering construction periods invariably increased the total project cost. Cost overruns in Taka took place frequently, but in many cases this reflected internal inflation, and project costs in US Dollars were often little changed.

Failure to implement the planning/design parameters during construction may reduce the expected benefit, as happened in Halir Haor Project. The embankment crest level there was about 1.5 ft. below the design crest for about 14 km., resulting in more frequent damage to the Boro crop.

Lack of proper compaction of embankments is a problem. This was particularly the case where embankments were constructed under the FFW programme (in which supervision is usually lax), were retired embankments or were parts of new projects that had been hastily constructed in a short period just before the onset of annual floods. In these cases there was generally inferior quality control (BRE).

The drainage canals on almost all the projects studied were either not excavated or were only partially excavated during the implementation period, although they were included in the plans and design. Absence of an effective drainage network is one of the major constraints on the drainage of scattered low pockets/depressions of the project areas.

Record keeping of the project works was found to be very poor at all levels and most of the project documents, including departmental feasibility reports, Project Proforma (PP), As-built drawings and Project Completion Reports were not available, at appropriate BWDB field offices.

3.3 OPERATION AND MAINTENANCE

3.3.1 Context

Although operation and maintenance (O&M) is not itself a project impact, an assessment of the often poor maintenance and/or operation of the projects was necessary to give an understanding of the reasons behind the projects' impacts or lack of impacts. The O&M of the projects was assessed in detail from engineering and social-institutional perspectives as part of the FAP 13 study.

Table 3.1 summarises the condition of the projects, the incidence of O&M problems over their lives, and the institutional arrangements for project operation. All of the projects are under the control of BWDB, but there is a great diversity in the performance and problems of the projects which makes it difficult to generalise. This section discusses the reasons behind the problems revealed in Table 3.1 and the extent to which they affect project performance.

The key issues in O&M are the extent of public participation, the availability of resources, and the adequacy of operation and maintenance to achieve the projects' primary objectives.

3.3.2 Embankments

All of the projects assessed have embankments (but Sonamukhi-Banmander has a very short embankment), and the condition of these was at the time of the study poor in all but three projects (Table 3.1). There are several aspects to embankment performance in preventing external floods.

Most maintenance is carried out periodically under FFW programmes. The only projects with routine maintenance programmes are submersible embankments (Halir Haor and Zilkar Haor) where damage due to the intended overtopping of the embankment must be repaired (under FFW) each year. In these projects there is a tendency for the crest level to gradually fall below design level due to insufficient FFW allocations or poor work. However, in Halir Haor 14 km. of embankment had not been constructed to the design standard so it was damaged more during submersion and so required more maintenance.

In projects where relatively recent resectioning had taken place, the embankments were in good shape. Even so it was apparent that there is inadequate prioritisation of the resources available for embankment repair work since in several projects (Konapara, Kurigram, Katakhali Khal) there have been gaps of different types for several years which undermine the intended flood protection benefit. In many projects regular damage occurs as a result of rain cuts, ghogs and wave action, but this is left unrepaired, often for several years, until rehabilitation is carried out. Routine maintenance is non-existent in these cases but could save resources and reduce the risk of embankment failure.

Breaches have occurred in 11 out of 16 projects. However, in several cases (BRE, Kurigram) these are due to erosion, typically because earth embankments were built in the active floodplain with an adequate setback; they are thus ultimately a planning problem. As a result of these planning failures there are high expenditures on protecting embankments, which appear under the heading of O&M works. Works found necessary include 'porcupines' (Kahua Muhuri, Kolabashukhali), groynes and boulder protection (Kurigram and MDIP), and brick mattressing (Chalan Beel). All of these measures are very expensive and direct scarce resources away from basic maintenance towards temporary protection of relatively inexpensive earthworks which may be doomed to erosion in any case. There is also a lack of evidence to prove the success of these protection measures.

In other cases, however, breaches have occurred in high floods, often (Chalan Beel, Katakhali Khal) where the embankment was weakened by irrigation inlets. Poor maintenance has probably also been a contributory factor.

Public cuts reflect wider problems than maintenance - in the few projects where they were made by outsiders the problem is serious and reflects adverse off-site impacts of the projects themselves (usually obstruction of flood flows which raises the river side flood level for a given discharge) and a failure to take mitigating measures to help those outside the project. Cuts by insiders are associated with drainage problems (see Section 3.3.5).

Many of the embankments have multiple uses, particularly as roads, but also with trees grown along them and as places of shelter - either in floods or more permanently when people are displaced by erosion from riverside land. These uses may be seen as an unintended benefit from the projects. However, it is apparent that they can contribute to maintenance problems, particularly in the case of housing. The maintenance problem arises because there is no framework for legitimising these uses and at the same time regulating them; hence there is at present no way to prevent damage and oblige users to maintain the embankment so that it can perform its primary function. Since it is in any case effectively impossible to evict people from the embankment, provision of such a framework would consolidate an important project benefit,

3.3.3 Structures - Engineering Aspects

Some problems with structures have already been noted to be associated with planning, design and implementation (Section 3.2). The commonest structures are regulators and sluices of various sizes. In some projects their structural integrity is threatened by a lack of maintenance of surrounding embankments (Katakhali Khal), while others have suffered from insufficient maintenance - rubber seals on flap gates often require re-alignment and replacement (KBK, Polder 17/2). Gate hoists and gears were sometimes found missing, preventing proper operation. Security for movable components of structures is essential. Wooden fallboards were generally found to create operational problems since they often warp and are easily misappropriated by vested interests (Silimpur-Karatia). Operation of regulators in submersible embankment projects is difficult since there is rarely enough time to equalise the water levels before the embankment is overtopped; also, fallboards cannot be removed when there is a large head difference (Halir Haor).

Design inadequacies can result in excessive maintenance requirements. Regulators with inadequate drainage capacity resulting in heading up of water, silting up of drains, and public cuts meant that maintenance requirements were higher than they should have been in a number of projects. Regulators built for a single function (drainage or flushing) are almost invariably used for both purposes (for example at Kolabashukhali). This results in damage to the structure and both increases operating hazards and maintenance costs (or shortens the structure's life when maintenance or redesign is not undertaken).

Poor investigations of sub-soil and choice of improper locations for structures have caused structures to settle (KBK and Uddhamdi pumping station in MDIP), resulting in impaired operation, high maintenance and repair costs, or the abandonment of structures (KBK, BRE).

Effective O&M is handicapped by poor documentation: the virtual absence of as-built drawings necessary for proper maintenance and major repairs, and the general absence of effective and useful O&M manuals which can result in inappropriate operation and hinders maintenance when it does occur.

3.3.4 Structures - Institutional Aspects

BWDB regularly employs khalashis to guard and operate its structures. This seems appropriate to larger regulators where it is important to follow correct operating procedures to avoid damage to the regulator and where operating decisions may be complex since the command area served is large and includes various land levels. However, khalashis were not found to have received any specific training or instructions in operating their regulators even when they were found to be present on site (KBK, Kurigram). Nor are there any simple operating and maintenance guides or manuals for the khalashis to follow - in fact they appear to have no formal instructions.

In a number of projects khalashis had been appointed but were absent (Protappur, Nagor River, Sonamukhi-Banmander). Operating decisions tend to be influenced by those with local power whether there is a khalashi or a committee or both. Not surprisingly, khalashis have little choice but to act under the direction of local influentials (for example the shrimp farmers in Polder 17/2) since they depend, like most people, on their patronage.

Local committees have been set up in a number of projects either to operate structures themselves (Katakhali Khal, Sakunia, Halir Haor) or to advise the khalashi on when to operate gates (Polder 17/2, KBK). However, in some large projects no committees have been formed, and in others they are not effective (Table 3.1). While committees may be under the domination of the local power structure this is not necessarily bad - where farmers have a common interest it helps to ensure timely operation and the security of the structure. However, there is evidence of differences of interest between those in power and farmers (for example collusion by the former with fishermen in Zilkar and Halir Haor). Operation may also be dominated by farmers of a particular land level or by those closest to the structure (KBK). The committees are not strong user groups and do not have any formal or semi-formal status - there is no linkage with cooperatives or NGO groups for example.

An important problem observed in all projects with existing committees (in name at least) is the lack of input from and training for BWDB staff in organising groups or in advising and assisting the committees or in arbitrating where disputes occur. Instead, this is more likely to involve the local administration (Zilkar Haor). There appears to be a lack of a coordinated water management plan in virtually all projects (with the exception of MDIP which depends on pumped irrigation and drainage and is a special case). In the case of Polder 17/2 effective operation is in the hands of shrimp farmers who have installed their own wooden sluices and the BWDB is unable to control land use or water management in the polder.

In general the division of responsibilities between local people, committees, khalashis and other BWDB staff does not appear to be clearly defined, and hence there is an opportunity for operation to be neglected. If operation is to be improved, and made appropriate to farmers' needs, the farmers need to be able to influence it. However, there is no monitoring of the needs of farmers and of the impacts of operating decisions.

Resources for structure operation do not appear to be a constraint, since large establishment budgets and overstaffing were found in some of the projects (Kurigram, KBK). For small structures paid khalashis appear unnecessary, as there is evidence that the same service may be obtained simply by giving a local person a user right (to a building or piece of land) in return for khalashi duties. Hence, there is scope for cost saving.

3.3.5 Drainage

Operation of structures is largely concerned with permitting drainage when river levels are low, and in keeping out flood water, with in a few cases water retention for supplementary irrigation (e.g. Protappur). However, an equally important aspect of drainage is the need for khals to be kept clear, which in most cases involves periodic re-excavation. In the majority of projects this was a problem, since khals are not re-excavated as frequently as necessary nor in a planned way (intermediary sections may be cleared and maintenance tends to be undertaken under FFW programmes which are determined more on equity than on drainage efficiency grounds).

Fourteen of the projects were found to suffer from some kind of drainage problem, and in eight this was severe enough to result in cuts by insiders to drain out water at times when river levels would have permitted it to be drained through regulators. A combination of poor planning, design and maintenance is implicated. One explanation is that drainage networks are incomplete, either because drainage basins were omitted from the plan or could not be linked to the network. If there is no regulator in a location where drainage is congested by an embankment (Halir Haor, Kurigram, Katakhali Khal), or if regulators are inadequate to cope with high internal rainfall (Kurigram), a public cut is the obvious local solution. However, there has been a lack of local responsibility for such actions. Only in Halir Haor was a regular cut repaired by voluntary labour. However, regular cuts and closures are not a long term solution since suitable earth is likely to become unavailable over time. Drainage excavation was not found to involve direct local participation, there being no incentive for people from one area to re-excavate when the effectiveness of their labour depends on other elements of the system also being maintained.

3.3.6 Irrigation

Only three of the projects - MDIP, Protappur and Kahua-Muhuri - had a major irrigation component, although in most others there is private groundwater or surface water irrigation. It is difficult to generalise from the experience in these projects. Protappur is a simple design, aimed at water retention for supplementary irrigation, which appeared to be very successful when first built but failed to achieve sufficient local involvement to maintain the system, probably because it was seen as a public good. Its objectives could nowadays be achieved through private tubewell irrigation, which has subsequently become widespread in the same area and is not a charge on public funds. The irrigation component of Kahua-Muhuri is also conceptually simple, consisting of a diversion weir and small surface distribution system.

MDIP reveals some of the problems in a major irrigation project, although availability of water has also been affected by damage to the infrastructure during the embankment failures. Formation of turnout-level irrigation groups has not been implemented, while no action has been taken to set or levy a water rate. Hence, there is little or no contribution either in cash or kind by farmers to system maintenance. The problems of the surface irrigation system are highlighted by the existence within the same project (in the areas where the flood-damaged canals are inoperable) of an alternative privately managed system of irrigation contractors operating LLPs and selling water to farmers, who pay the cost of the service in full. The failure to set a levy to cover the very high operating costs of the combined FCD/I system (pumped drainage and irrigation) forms a dangerous precedent, since farmers are experiencing windfall profits and are encouraged to use water inefficiently. This is an example of a project with a complex O&M manual and intended institutional arrangement which has not been operationalised and was not implemented during the project implementation phase.

In irrigation there are examples of private water management, some involving local participation in surface systems (tidal irrigation in KBK, surface inlets in Kahua Muhuri, and cross bunds previously in several projects including Protappur and Sonamukhi-Banmander). However, there was no evidence of BWDB trying to build on these local informal institutions to develop local direct participation in maintenance or management of project facilities, even at Protappur where the irrigation project was conceived as a direct replacement for the existing system. Project facilities in all cases appeared to have been planned in isolation from the local social and institutional context and consequently there has been little local involvement in O&M.

3.4 FLOODING, DRAINAGE AND IRRIGATION

3.4.1 Changes in Flood Characteristics

The 17 projects evaluated were specifically selected to represent the range of flood types and regional variations found in FCD/I projects in Bangladesh. There are two main aspects to flood control in these projects. Firstly they are designed to modify "normal" monsoon water levels and timings on cultivable land (by excluding external water and improving drainage), thus increasing agricultural production. Secondly they are intended to keep out peak floods up to some specified design standard, and thereby protect crops, property and infrastructure from damage. Table 3.2 summarises the hydrological impacts and types of projects. Overall there is a great diversity in the impacts with changes in the normal duration and timing of flooding changing in association with changes in flood depth. The later was assessed in detail in the PIEs (Table 3.3). The impacts of the projects are summarised here by flood type.

a) Major river monsoon floods

Flood peaks along the three main rivers can bring rapid increases in water levels, and longer overbank spills during the peak flow period (July-September). In all the projects assessed (BRE, MDIP, Kurigram) normal water levels were reduced, but in Kurigram the impact was less as this area also is at risk from flash floods and is relatively high, while MDIP has been highly successful through pumped drainage in reducing normal water levels (Table 3.3). However, these projects have had much less success in keeping out peak floods, mainly because of breaches, erosion and flows from upstream areas and not overtopping.

b) Local flooding and internal drainage basins

River levels back up in the monsoon in the lesser rivers, and the beels and floodplains are flooded by rainwater. The majority of projects studied experience this type of flooding (Table 3.2). Although these projects vary in size, they were all intended to provide full flood protection with the exception of Sonamukhi-Banmander which is essentially a drainage improvement project.

Table 3.1 Operation and Maintenance Performance

(As observed during field visits in the 1991 monsoon season)

Name of Project	Percentage Embankment in poor condition	Embankment use			Erosion	Breaches	Cuts by insiders	Cuts by outsiders	Khalashis active?	Local committees active?	Private surface water management	Participation in embankment protection
		road	house	trees								
Chalan Beel	50%	1	0	2	0	1	2	2	1	0	2	1
Kurigram	+50%	2	2	2	2	2	2	0	2	0	0	0
Meghna-Dhonagoda	20%	2	1	1	2	2	0	0	2	1	2	0
Zilkar Haor	70%	1	0	0	0	0	0	0	2	1	2	1
Kolabashukhali	50%	2	0	1	1	0	0	0	2	0	1	0
Protappur	90%	1	1	1	0	0	0	0	0	1	1	0
Nagor River	85%	2	0	1	2	0	1	2	0	0	0	0
Sonamukhi	na	na	na	na	na	na	0	*	0	0	2	0
Sakunia Beel	70%	1	0	1	1	1	0	0	0	1	1	0
Silimpur	15%	2	0	1	1	1	0	0	na[1]	0	0	0
Katakhali Khal	50%	2	0	0	0	2	2	0	0	1	1	1
Halir Haor	33%	1	0	0	0	1	2	0	0	1	2	1
Kahua-Muhuri	80%	1	0	1	2	1	2	0	0	2	2	1
Konapara	60%	2	0	1	1	2	0	1	na	0	2	0
Polder 17/2	5%	2	0	0	0	0	2[2]	0	2	1	2	0
BRE-Kamarjani	70%	2	2	2	2	2	2	0	2	0	0	0
BRE-Kazipur	50%	2	2	2	2	2	0	0	na	na	0	0

Source: FAP 12 PIEs and RRAs, FAP 13 Final Report

Notes: 0 = no 1 = yes - some/partly 2 = yes, much/many.
[1] In Silimpur the sluices are not operated.
[2] In Polder 17/2 the cuts are for installation of wooden box sluices for shrimp farms.
* Cuts and conflict over non-project bunds affect project area.

Table 3.2 Summary of Key Hydrological Impacts

Flood type	Project Name	Present Flood Characteristics: Inside Project: Delayed onset of floods	Inside Project: Reduced normal flood depth	Inside Project: Prevented peak floods	Inside Project: Drainage congestion	Outside Project: Silta-tion	Outside Project: Back-flow	Outside Project: Bank erosion	Outside Project: Water level	Impact of Breaches/ Public cuts
L	Chalan Beel Polder - D	Yes	Yes	(Partly) Yes	I^{**}	Yes	No	Yes	I^{**}	B^{*} P^{***}
M/F	Kurigram South	Yes	Yes	Partly	I^{**}	Yes	No	Yes	0	B^{*} P^{**}
M	Meghna Dhonagoda Irrigation Project	Yes	Yes	(Partly) Yes	Eliminated Fully	No	No	Yes^{***}	0	B^{***}
H	Zilkar Haor	Yes	Yes/No+	Yes/No+	D^{*}	Yes	No	No	I^{*}	-
T/L	Kolabashukhali	TIDAL	Yes	Yes	D^{*}	Yes	TIDAL	Yes	I^{*}	-
L	Protappur Irrigation Project	Yes	Yes	Yes	0	Yes	No	Yes	I^{*}	-
L/F	Nagor River Project	Partly	No	No	I^{*}	Yes	Yes^{***}	Yes^{***}	I^{**}	P^{***}
L	Sonamukhi-Banmander Beel Drainage Project	No	Yes	Yes	D^{*}	Yes^{***}	Yes^{**}	No	I^{**}	-
L	Impv. Sakunia Beel	Yes	Yes	Yes	D^{*}	No	Yes	Yes	I^{*}	B^{**}
L	Silimpur-Karatia Bridge-cum-Regulator	No	No	No	I^{*}	Yes	No	Yes	I^{**}	B^{*}
L	Katakhali Khal	No	Yes^{**}	No	I	Yes	No	Yes	I^{*}	P^{**} B^{**}
H	Halir Haor	Yes	No	No	D^{*}	Yes	Yes	No	I^{*}	P^{*} B^{*}
F	Kahua-Muhuri Embankment	Yes	Yes	No	I^{*}	Yes^{***}	Yes	Yes^{***}	I^{*}	B^{***} P^{***}
F	Konapara Embankment	Yes	Yes^{**}	No	I^{*}	Yes	Yes	Yes	I^{**}	B^{*} P^{**}
T	Polder 17/2	TIDAL	Yes	Yes	I^{*}	Yes^{*}	TIDAL	No	I^{*}	P^{**}
M	BRE - Kamarjani	Yes	Yes	Yes	I^{***}	Yes^{***}	No	Yes^{***}	?	P^{***} B^{**}
M	BRE - Kazipur	Yes	Yes	Partly	0	Yes^{***}	Yes	Yes^{***}	?	B^{***}

Source: RRA Reports

Notes:

Flood Type: M = monsoon flood on main river; L = local flooding and internal drainage; F = flash floods; H = haor areas; T = tidal flooding.

Impacts: Yes = Intended target achieved; No = No impact apparent;
I = Increase/Rise; D = Decrease/Fall;

Scale of Impact: * = Moderate; ** = Medium; *** = Severe;

Problems: B = Breach; P = Public cut;

+ yes in full flood protection part, no in submersible embankment part

In general these projects have successfully reduced normal monsoon water levels, although this is not always by a large amount (note the small changes between flood depth categories for Chalan Beel where drainage congestion has increased, Table 3.3). Exceptions are Nagor River which has a regular problem of cuts/breaches which results in the lower part of the project being at least as deeply flooded as in pre-Project conditions each year, and Silimpur-Karatia where flood protection has never been provided along one of the adjacent rivers. These same two projects are the main exceptions where peak floods also have not been excluded, although other projects also flooded from outside in 1988 (Katakhali Khal and Chalan Beel D), and in others local drainage congestion was worse.

c) Flash floods

In areas adjacent to the hilly regions bordering Bangladesh small rivers are subject to rapid flash floods of relatively short duration. Typically flash floods of moderate magnitude occur each year, sometimes more than once in a year, and naturally these are extreme in some years. In both projects which protect only from this type of flooding the embankments were successful in preventing flash floods of normal elevation, and hence protecting crops, but were not able to exclude peak floods (such as in 1988). A similar pattern was found in Kurigram (where the Teesta is 'flashy') and Nagor River. In these two cases morphological changes - erosion and bed raising - have limited the hydrological benefits.

Table 3.3 Distribution of Area by Flood Depth in Protected Area of PIE Projects
(% of cultivated land)

Land level	Chalan Beel Polder 'D'		Kurigram South		MDIP		Zilkar Haor		Kolabashukhali	
	Before	After	Before	After	Before	After	Before	After	Before	After
High	13	28	43	47	0	64	0	3	4	8
Medium H.	9	10	8	16	0	15	7	5	6	18
Medium L.	20	21	27	24	8	10	17	26	19	30
Low	37	23	17	11	53	8	42	34	42	39
Very Low	21	18	5	2	39	3	35	32	29	5
Total	100	100	100	100	100	100	100	100	100	100

Source: FAP 12 Final Report, Volume 3 Appendix G

Note: Land levels relate to normal monsoon water levels.

High	=	not flooded;	Low	=	90-180.cm (F2);
Medium High	=	0-30 cm (F0);	Very Low	=	>180 cm (F3+F4).
Medium Low	=	30-90 cm (F1);			

The F levels refer to the MPO. standards.

d) Haor areas

In the north-east region are lowlying basins which experience an early inflow of flood water, which could be termed flashy since the timing of early floods is uncertain, followed by a prolonged period of very deep flooding. In these circumstances submersible embankments are used (Zilkar Haor, Halir Haor) to exclude floods until the Boro paddy is harvested and then permit normal and extreme flooding. Hence there is no intention of preventing peak or even normal flood levels (although in Zilkar Haor part of the area has been given full flood protection). These projects have been successful in delaying the onset of floods in most years (see Volume 3 Appendix G for further details of timing).

e) Tidal flooding

In coastal and near coastal areas polders protect against: saline water intrusion, tidal flooding, and to some extent against cyclonic flooding and tidal waves. The two projects of this type evaluated were successful in excluding saline water and normal flooding to the extent that interests inside the projects would allow. Kolabashukhali has reduced normal water levels considerably enabling expanded cultivation. In Polder 17/2 long delays in completing the project were made partially redundant by the growth of shrimp farming and management of saline water inside the project. Both projects have so far been successful against peak floods, but are not in a critical cyclone prone area.

3.4.2 Drainage Problems

The primary objective of embankments in FCD/I projects is to protect the project area from the intrusion of external water during the flood season. However, the enclosure of the project area with the embankment inevitably hinders drainage of internal water. The extent to which this can be overcome by gravity drainage depends on the infrastructure provided (regulators and re-excavated khals) and on the external water levels.

Drainage requirements are normally determined by basin area, local rainfall, moisture capacity in the basin, and transpiration/evaporation. However, the drainage problem becomes serious and unpredictable when a project receives water from outside the project area (Sonamukhi-Banmander).

The capacity and operation of the drainage system are also important factors determining the effectiveness of drainage. In most of the full flood control projects studied drainage congestion was a problem (of varying severity, Table 3.2). This is inevitable since regulators can only be opened for drainage when internal water levels exceed the external level. Monsoon water levels often limit this period in Bangladesh to the post-monsoon period, except on flashy rivers when drainage is possible after peak flows.

Embankment construction along both sides of small rivers results in higher stages for normal flows because the river flow is confined, and this reduces the opportunity for gravity drainage (Nagor River Project). This is the result of the project or projects and should be distinguished from natural backwater effects.

Public cuts by insiders are relatively common (Table 3.2) and imply that drainage capacity is insufficient to meet the needs of farmers even when external water levels fall. Half of the projects (9 out of 17 projects in Table 3.2) suffer from drainage congestion after the project. Local people in many of the projects studied have requested additional regulators to alleviate the drainage congestion, but BWDB cannot respond in most cases due to financial constraints. Innovative alternatives for drainage operation including provision for authorised public cuts should be envisaged to reduce the need for additional regulators.

The projects with reduced drainage problems reflect project design. Out of the drainage projects the two most effective were Kolabashukhali where tidal drainage is possible even during the monsoon, and MDIP where pumped drainage was provided. While pumped drainage is technically efficient, it has high operating costs, which are likely to become burdensome as there has been no attempt so far to recover these costs.

It should be noted that the impact of drainage congestion may be negative for agriculture but is positive in terms of fisheries, aquatic vegetation, groundwater recharge, and overall rural amenity. A certain water surface area could be conserved in FCD/I projects to reduce the negative environmental impacts.

3.4.3 Regional Hydrological Changes

Bangladesh is a flat alluvial delta, crossed by numerous rivers, tributaries and distributaries. These change course frequently and there is high sedimentation. Although no detailed surveys of siltation or river morphology could be carried out as part of FAP 12, it was clear from local opinion expressed in the RRAs that people have seen river beds rising generally in the last decade or more (15 out of 17 projects, Table 3.2). It is arguable that this has been accelerated by the confinement of rivers by the many embankment projects, and that the difference between river bed and land levels has narrowed as silt deposition is prevented inside projects.

The apparent success of FCD/I in the PIE projects in reducing normal flood depths, which was also evident in the RRA projects, may therefore only be a short-term benefit. Analysis of hydrographs from some of the gauging stations near the PIE projects appears to support the argument of rising average flood levels, but this cannot be proven since the period of record available in most cases is insufficient.

Further research is warranted on this issue. If FCD projects do have this impact their effective lives will be less than expected, their standard of protection will decline over time, and Bangladesh will be faced with a perpetual need to raise embankment levels to avert the risk of disastrous floods in protected areas. If the risk of overtopping and breaches increases over a project's life, then the benefits are likely to be overestimated.

3.4.4 Irrigation Availability

Irrigation is the leading factor in agricultural development in Bangladesh enabling HYV Boro cultivation. Concurrent with the FCD projects evaluated, there has been a rapid growth in minor irrigation development. Most of the projects evaluated are FCD projects, although in a number pipe inlets were provided to facilitate existing irrigation by LLP through the embankments. In general the impression from the RRAs was that FCD has not induced greater irrigation development than in non-project areas.

Table 3.4 Percentage of Cultivated Area Irrigated in Farm Households in PIE Projects

Project	Season	Impacted						Control		
		Protected			Unprotected					
		Total cropped land (ha.)	% area irrigated by		Total cropped land (ha.)	% area irrigated by		Total cropped land (ha.)	% area irrigated by	
			Indigenous methods	Mechanical methods		Indigenous methods	Mechanical methods		Indigenous methods	Mechanical methods
Zilkar Haor	Boro	50.71	50	38	30.04	30	64	18.16	51	6
	Aus	7.76	29	0	6.33	0	4	17.65	1	0
	Aman	52.96	18	2	39.64	9	3	57.55	6	0
Chalan Beel	Boro	54.96	42	47	4.70	19	71	23.80	22	72
	Aus	19.20	12	3	2.14	13	29	9.26	21	13
	Aman	50.54	10	3	8.59	0	0	16.22	17	9
Kolabashukhali	Boro	23.78	2	24	-	-	-	27.13	9	4
	Aus	65.39	0	1	-	-	-	28.97	0	0
	Aman	96.30	0	0	-	-	-	41.99	0	0
Kurigram South	Boro	38.69	8	73	5.70	5	35	34.04	7	57
	Aus	41.49	7	1	2.95	0	3	31.20	0	5
	Aman	60.14	0	5	6.08	0	0	57.61	0	0
Meghna Dhonagoda	Boro	45.66	3	80	-	-	-	18.21	9	25
	Aus	39.72	0	5	-	-	-	5.39	3	0
	Aman	49.22	0	7	-	-	-	20.87	1	0

Source: PIE surveys

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Table 3.4 shows that in the PIEs the two typical FCD projects (Chalan Beel D and Kurigram) have the same incidence of irrigation as their control areas. In Kolabashukhali irrigation is not widespread but appears to be more common, which may have been induced by better drainage and early protection of Boro. The same appears to be true of Zilkar Haor where there is a much higher incidence of irrigation (90 per cent of winter cultivation) than in the control area (56 per cent); however, the non-protected impacted area also shows the same trend. MDIP is the only major project studied with an irrigation component and this has approximately doubled the incidence of winter irrigation over the control area.

3.5 AGRICULTURAL IMPACT

3.5.1 Introduction

In most cases FCD/I projects are justified on the grounds that they will improve conditions for agriculture. More particularly, depending on the project, it is argued that:

- reductions in normal monsoon water levels, durations, and rates of rise in water level will all encourage farmers to adopt more productive crops (paddy varieties) which cannot tolerate unmanaged monsoon conditions;

- damages in unusual floods will be reduced, resulting in higher average yields for a given crop;

- reduced variation in monsoon conditions reduces the risks facing farmers, who are then encouraged to adopt HYV technology (which would otherwise entail high losses in flood years because the costs of production are higher); and

- irrigation makes possible a change from low production rabi crops to more profitable and productive HYV Boro in the winter.

The eventual results of such influences may be an increase in cropping intensity, more stable yields and outputs, and in a few cases an expansion of cultivated area. The ultimate aim has almost invariably been to produce more paddy.

In the RRAs group interviews with farmers were to investigate the differences between pre- and post-Project agriculture, whereas in the PIEs a formal sample survey investigated agriculture on the land of sample farmers during 1990-91 in the project and in control areas. Hence the findings in the two sets of projects are not necessarily comparable, although in many of the RRAs an attempt was made to estimate what would have happened without the project, or at least which differences were attributable to the project.

3.5.2 Cropped Areas and Choice of Crops

a) Cropped Areas

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

In relatively few projects has there been an increase in the net cultivated area since most potentially cultivable land in the projects was already cultivated in at least one season before FCD/I was provided. However, in several the area of excess monsoon water, in the form of near permanent beels, has been reduced for long enough to permit a crop for the first time (effectively land reclamation). In the submersible embankment projects (Halir Haor and Zilkar Haor) improved drainage and the embankment have permitted small areas of beel fringes to be cultivated. In Kolabashukhali 2000-5000 ha. of the beels are now dry enough in time to prepare land for a B Aus+Aman crop following the reduction in monsoon water levels. There has also been conversion of beel fringes to cultivation (usually for Boro) in some other projects. For example, in Sakunia Beel and Sonamukhi-Banmander this was judged to have been facilitated by the Project, but in Katakhali Khal it was thought to reflect a natural drying/silting up of the beels.

More generally FCD/I projects have changed the incidence of seasonal cropping (see Table 3.5). The least benefited season is the early monsoon (kharif I or Aus and jute). This is generally because the expansion of irrigation (project or non-project) has replaced these crops with more profitable HYV Boro which overlaps the traditional early monsoon growing season. Had there not been irrigation, flood protection might have benefited these crops. The exceptions are Polder 17/2, where irrigation is only just being introduced and jute expanded as salinity fell, and MDIP, where there has been a major expansion of Aus as a single crop (rather than as mixed Aus+Aman) as farmers exploit the opportunities of free irrigation water and pumped drainage to the full.

There have been few if any increases in Aman season cropping intensity (the expansion in KBK being into new areas). In Nagor River the Aman cropped area declined because the combined impact of the Atrai basin FCD projects has led to regular public cuts which have worsened hydrological conditions. In Zilkar Haor there is less Aman than in the control area and there has been a decline in B Aman which has been replaced by Boro (which is more profitable but does not permit Aman to be broadcast before the area is deeply flooded).

Whilst expansion of Boro does not always imply an increase in winter cropping intensity, this has often been the case. However, it has been necessary to critically examine the linkages between project impacts and changes in Boro cultivation (this relates to cropping choices as much to cropped areas). In some projects expansion of winter cropping involving the expansion of Boro has been fully excluded as a project benefit, and in others only part of the change can be linked to the project (for example KBK, Katakhali Khal, Sakunia Beel), since some or all of the growth in small scale irrigation would have happened anyway and the projects do not protect from early floods. However FAP 12 found three ways in which FCD/I projects did expand the Boro/rabi area:

- by providing protection against early flooding which damages Boro at harvesting time (Zilkar and Halir Haor) and by draining beel fringes; this produces a small impact on area in Haor areas since Boro was already widespread, but a greater area impact in some beel areas;

- by protecting from saline flooding, enabling rabi crops and Boro to be grown, the latter depending on irrigation availability (Polder 17/2); and

- by providing or facilitating the provision of irrigation water for HYV Boro (MDIP, Kahua-Muhuri).

Even where the Project included provision of irrigation facilities, it is necessary to assess whether irrigation could have been supplied by minor irrigation techniques not integrated into an FCD/I project.

The general patterns across all project areas (Table 3.5) is of about 8 projects showing no change in cropping intensity due to the project. In the remaining projects there have been relatively small changes in Aman season cropping intensity (four positive, three negative). In Nagor River, Chalan Beel D and BRE Kamarjani the risk of breaches and public cuts has reduced Aman intensity. There are rather more projects which show increases in winter cultivation, but these cannot be attributed to the projects in several cases.

b) Choice of crop varieties

Overall, FCD/I Projects have strengthened the dominance of paddy in cropping patterns, particularly to the extent that they have promoted Boro at the expense of rabi and jute crops. To some extent Aus has been replaced by more productive HYV Boro (with the exception of MDIP where ample irrigation has made it possible to fit both crops into some areas, although this may be only a transitional phase).

The main impact of FCD is in inducing changes within the monsoon cropping pattern, in particular from B Aman or B Aus+Aman to Local T Aman, or even HYV Aman (and in a very few cases Aus followed by T Aman); and also from Local T Aman to HYV Aman. This is a direct reflection of a reduction in normal monsoon water levels and in the risk of higher flood levels -a more stable environment encouraging the cultivation of varieties with higher costs of production and higher returns.

3.5.3 Crop Yields

Yield of paddy (the only or the most important crop for all the areas) on a weighted average basis has increased in all but one of the 17 study areas (the exception being Nagor River. Increases in average yield following flood protection arise from three factors - a switch to HYVs, increased use of crop production inputs given lower perceived risk of crop failure, and reduced annual or periodical losses due to flood. All of these have been identified as significant during the RRAs and the PIEs. Input use, particularly the use of chemical fertilizer, has increased significantly in the case of HYV crops and Local T Aman in all 5 PIE areas.

The majority of projects have raised total paddy yields (averaged over all varieties and seasons), in the outstanding case of MDIP by 1.9 mt./ha.. The exceptions are the poorly-planned Chalan Beel Polder D, where there is negligible yield difference between the impacted and control areas, and the even more ill-conceived Nagor River Project, where the RRA concluded that yields had actually fallen due to deterioration of the hydrological regime.

The PIEs indicate that, in general, the yields of Aus and Local T Aman paddy are higher for a given land level inside the projects compared with control areas which is consistent with the Projects providing greater security from fluctuations in water levels during an approximately normal year. Additionally in Kolabashukhali B Aman and B Aus+Aman yields are better inside the Project (where they are protected from tidal fluctuations in water level). In MDIP HYV Aman yields are higher than in the control area reflecting the benefits of controlled drainage. In Zilkar Haor in a year with some flood damages paddy yields were higher in the Project reflecting its effectiveness in a flood; in the other projects greater differences might be expected in a severe flood, except for Chalan Beel D where cuts and breaches may cause greater damages for a given land level.

However, in most projects the major impact on overall paddy yields is from farmers switching to more productive types of paddy when hydrological conditions change sufficiently to permit this (see 3.5.2 (b) above).

3.5.4 Crop Production and Output

As indicated earlier, paddy is by far the most important crop in the cropping patterns of all the study areas. Changes in output of paddy, annual or periodical, should therefore be considered as the major indicator of project impact. Under this consideration estimates have been made for output changes under 'with' and 'without' project situations through extrapolation of per hectare paddy yields with benefited paddy cropped land due to the project. The results are presented in Table 3.5, which shows an increase in output ranging from 7 per cent in Silimpur-Karatia and Chalan Beel (RRA and PIE estimates, respectively) to 95 per cent in Polder 17/2 (RRA), 144 per cent in Kolabashukhali (PIE), 158 per cent in MDIP (PIE), and 241 per cent in Sonamukhi-Banmander (RRA) in the with-project situation. This increase is due to reduced flood hazards due to flood protection and the switch to HYVs in many cases. In the three highest cases there was substantial growth in Boro cultivation due to the projects. The switch to HYVs together with the shift from broadcast to transplanted local varieties has raised yields (see Section 3.5.3 above) in the impact areas. Output changes are also influenced by intensity changes, in the cases where these have been significant (see 3.5.2 (a) above).

3.5.5 Crop Production Inputs

As the FCD and FCD/I projects have generally succeeded in reducing crop losses due to floods, and farmers in the impacted areas have therefore to a considerable extent switched over to higher yielding crop varieties, more crop production inputs are now used. Farmers in all the PIE areas have been found to have invested more in crop inputs - particularly in chemical fertilizers, pesticides and irrigation - in the impacted than in the control areas. Farmers in the Zilkar Haor impacted area, for example, spend 8 times more on chemical fertilizers than the control area farmers. In Meghna-Dhonagoda, Kolabashukhali and Kurigram impacted areas the farmers use about double the amount of chemical fertilizer used by their counterparts in their respective control areas. A similar trend exists in case of irrigation and pesticide use. One of the reasons for this increase is that the farmers in the impacted areas now give more weight to cultivation of HYVs and/or transplanted local varieties, particularly Local T Aman and HYV Boro, which use more of these inputs compared to broadcast varieties.

Nevertheless, in those cases where the same crop is produced in both the impacted and the control areas, with only a few exceptions the impacted area uses more production inputs than the control area. All these results reflect the fact that the farmers in the impacted area face reduced risks due to the projects' successes in reducing crop losses due to floods.

3.5.6 Value of Crop Output and Net Return

The annual aggregate net output value of crops, including the value of by-products, was much higher in the impacted areas of the 5 PIEs than in their respective control areas. Although increase in input use is expected to have a bearing upon increase in value of output, the proportionate increase in output value is much higher than the increase in input costs, indicating that farmers in the impacted areas obtain better returns to inputs. This is again indicative of greater security, as well as of the switch to varieties which utilise inputs more productively. In three of the PIE project areas the difference in output value between impacted and control areas ranges from more than 200 per cent in Meghna-Dhonagoda and Kolabashukhali and 23 per cent in Kurigram, against differences in production costs of less than 20 per cent. In Zilkar Haor the difference in production costs was of the same order, but output value was 10 times higher in the impacted than in the control area. This was however a seasonal effect, caused by flood damage to the 1990 Boro crop in the control area. The major impact is clearly created by protection of crops from flood damage.

In Chalan Beel, net output value for the protected area was 44 per cent higher than for the control, but this appears to have been influenced by seasonal factors which gave the 'protected' area a superiority it does not normally possess. The difference in physical output in the survey year is small (see Table 3.5), and the indications are that control area farmers use if anything rather more inputs than those in the 'protected' area, which has no significant superiority over the control in a normal year. This is due to the persistent problem of public cuts which creates considerable uncertainty for farmers inside the project, who are consequently unwilling to risk high input applications on crops which may be lost due to cuts.

The conclusions on superiority of the protected areas are strengthened by findings on net output value in some of the control areas. In 1990 in the Zilkar Haor control area, for example, farmers incurred financial losses (with family labour costed at the market wage) in Local Boro and B Aman production, the two major crops produced in the area. In the Kolabashukhali control area the farmers incurred a financial loss in B Aman production, the most important crop produced, due to the impact of storm damage; the project area farmers also suffered damage, but with higher normal yield levels their absolute output value did not fall as far. It is not, of course, likely that the majority of farmers made an overall cash loss, since family labour comprises the major input, but it is clear that such labour was more poorly rewarded in the control areas than in the impacted areas. It should be mentioned here that in estimating the output values the same prices have been used for both the impacted and the control areas, to avoid possible distortion of the comparison.

3.5.7 Summary of Agricultural Impacts by Project Type

Based on the five types of flooding and project types discussed in Section 3.4, the following agricultural benefits and limitations on their achievement have been found.

a) Major river monsoon floods

Typically these projects protect transplanted Aman, and may induce the same changes as the next category. They did not appear to protect Boro in the cases studied. Limiting factors are drainage facilities and the risk of embankment breaches and erosion which may remove the intended sense of security.

b) Local Flooding and Internal Drainage Basins

The main benefits are from Aman cultivation - encouraging a change from B Aman to TL Aman and from TL Aman to HYV Aman. Also, yields may be more secure and on average higher. The expansion of Boro did not appear to be due to the projects, although they may provide flood protection at harvest time. The main limitation is drainage facilities, but problems of external impacts and public cuts (by outsiders and insiders) are particularly acute in this project type.

c) Flash Floods

Embankments protecting against flash floods typically protect both Boro (from early floods) and monsoon season crops (from flood peaks during the main monsoon). This may permit Boro to be grown (compared with rabi crops which are harvested earlier) and typically increases the average yield achieved for T Aman; the security may also encourage HYV Aman cultivation. Limiting factors are the availability of irrigation, and the risk of failure of the embankments.

d) Haor areas

Submersible embankments generally result in higher average annual yields for L Boro, and may result in increased areas under Boro cultivation and a switch to HYV Boro where there is greater security for irrigation expansion. Limiting factors are the risk of early overtopping (embankment design and maintenance), and post-monsoon drainage facilities.

e) Tidal Flooding

On higher land the coastal polders encourage increased winter cropping intensity by eliminating saline water and gradually reducing soil salinity levels, while in lower areas the main gains may be to monsoon season cropping - either by an expanded area, protection from floods, or a switch to higher yielding varieties. Limiting factors are the slow reduction in salinity levels and shrimp farming, which requires controlled inflows of saline water and unregulated may harm cultivation in adjoining areas and after the shrimps are harvested.

To these types must be added the influence of irrigation in projects which include an irrigation component. This is invariably used for HYV Boro cultivation (MDIP, Kahua-Muhuri, Polder 17/2) and occasionally for HYV Aus (MDIP), but may help to secure a T Aman crop in relatively dry areas (Protappur). O&M appears to be the limiting factor.

3.6 IMPACTS ON LIVESTOCK

3.6.1 General Comments

The projects studied generally had no explicit objective related to livestock development. However, all FCD/I Projects have explicit objectives for increasing crop production, particularly paddy production, through changing cultivable area, cropping pattern and cropping intensity. It is therefore expected, *a priori*, that those projects which succeed in increasing cropping area and cropping intensity will lead to reductions in fallow land and grazing area for livestock on one hand, and increased requirements for draught animals on the other. It is anticipated that changes in the availability of feeds will lead to changes in production costs and thereby will create an impact on livestock output. The planners, at the time of project planning, have rarely considered project impacts on draught power requirements, and how to meet the increased demand for draught power for timely land preparation.

The results of all 12 projects studied by RRA and the 5 projects studied by PIE indicate varied impacts on livestock production. In some projects there were clear negative impacts while in other cases there was little or no clear impact. The impacts of the projects on livestock are summarized in Tables 3.6 and 3.7, and are discussed below.

Table 3.5 Summary of Project Agricultural Impacts

Project	Change in Cultivated Area	Change in Cropping Pattern	Change in Cropping Intensity	Change in Paddy Yield	Change in Paddy Output	Change in Input use	Change in Value of Output
				RRA Data			
Protappur	No change	Shift from TL Aman to HYV T Aman	No change due to project (annual)	+ve; 2.5 to 4.5 mt/ha (monsoon paddy)	+5417 mt (57%)	NA	NA
Nagor River	-1370 ha. (22%) in monsoon. Increase in boro/rabi only marginally due to Project	Partial shift from B Aman to T Aman. Marginal influence on growth of HYV Boro	-ve in monsoon	-ve; 2.44 to 2.02 mt/ha (monsoon paddy)	- 2902 mt (24%)	NA	NA
Halir Haor	+6%	Small shift to HYV Boro	No change	+ve; 1.1 to 1.37 mt/ha (all paddy)	+ 2253 mt (33%)	NA	NA
Konapara	No change	Partial shift from LT Aman to HYV Aman	No change due to project	+ve; 1.92 to 2.48 mt/ha (monsoon paddy)	+2095 mt (17%) (monsoon paddy)	NA	NA
BRE Kamarjani	No change	Shift from B Aus & Aus/Aman to LT & HYV Aman	-ve; 79% to 58% (monsoon)	+ve; 1.82 to 2.38 mt/ha (monsoon paddy)	+ 444 mt (11%)	NA	NA
BRE Kazipur	No change due to project	Shift from B Aman to T Aman	No change due to project	+ve; 1.82 to 2.38 mt/ha (monsoon paddy)	+2710 mt (26%) (monsoon paddy)	NA	NA
Silimpur-Karatia	None	Partial shift from B Aman to L & HYV T Aman	+ve; 180% to 190% (annual)	+ve; 1.31 to 1.48 mt/ha (monsoon paddy)	+77 mt (7%) (monsoon paddy)	NA	NA
Polder 17/2	small +ve impact	Shift from fallow or shrimp to rabi-Boro, from TL Aman to HYV T Aman	+ve: 100% to 143% or 152% to 176% (including shrimp) (annual)	+ve; 1.95 to 2.97 mt/ha	+4770 mt (95%) (all paddy)	NA	NA
Katakhali Khal	None definitely due to Project	Shift from B Aman to L & HYV T Aman	+ve; 47% to 71% (monsoon)	+ve; 2.18 to 3.22 mt/ha (monsoon paddy)	+1492 mt (50%)	NA	NA
Kahua-Muhuri	+1200 ha. (74%) in Boro	Shift from B Aman & Aus/Aman to T Aman/HYV Boro	No change	+ve; 3.24 to 4.08 mt/ha (all monsoon paddy & Project-influenced Boro)	+10356 mt (50%)	NA	NA
Sakunia Beel	+540 ha. (12%) in Boro	Shift from B Aman & Aus/Aman to T Aman/HYV Boro	No change	+ve; 1.64 to 1.90 mt/ha (all seasons)	+1311 mt (14%) (all paddy) Wheat +332 mt (64%)	NA	NA
Sonamukhi-Banmander	+405 ha. in Boro	Shift from Aus to Boro; from B Aman to T Aman; from TL Aman to HYV Aman	No change (monsoon)	+ve 1.54 to 3.92 mt/ha (monsoon paddy)	+20721 mt (monsoon and reclaimed boro land)	NA	NA
				PIE Data			
Chalan Beel	+11% in monsoon -20% in Boro/Rabi	Shift from B Aman LV to T Aman LV	-ve; 142% to 124% (annual)	+ve; but slight; 2.69 to 2.88 mt/ha (all paddy)	+8067 mt (8%)	-10% in agg. (annual)	44% (annual)
Kurigram	+25% in Aus +8% in Boro/Rabi	Shift from B Aman LV to T Aman LV	+ve; 174% to 190% (annual)	+ve; 2.19 to 2.84 mt/ha (all paddy)	+57227 mt (38%)	+14% Ch. Fert +126% Post. +30% Irrig.	+23%
Meghna-Dhonagoda	+204% in Aus -6% in Aman, No change in Boro/rabi	Significant shift to T Aus HYV & marginally to B Aus HYV from B Aus LV & Boro LV & to T Aman HYV from B Aman LV to Boro HYV from Boro LV & Wheat	+ve; 189% to 209% (annual)	+ve; 2.52 to 4.37 mt/ha (all paddy)	+74000 mt (176%)	+126% Ch. Fert. +300% Pesticides	+206%
Zilkar Haor	-25% in monsoon +126% in Boro	Shift from B Aman LV to T Aman LV and Boro LV to Boro HYV (Boro LV is still imp.)	+ve; 23% to 52% in Boro, -ve; but slight: 117% to 113% (annual)	+ve; 1.04 to 2.08 mt/ha (all paddy)	+4704 mt (91%)	+800% Ch. Fert. +160% Post. +600% Irrig.	+966%
Kolabashu-khali	+74% in Aus +52% in Aman -40% in Boro/Rabi	Shift from Jute to Aus/Aman mixed & from B Aman LV to T Aman LV	No change	+ve; 1.00 to 1.71 mt/ha. (all paddy)	+25072 mt (144%)	+50% Ch. Fert. +1300% Irrig.	+255%

Source: Consultant's estimates

3.6.2 Incidence of Livestock Ownership and Livestock Holding Size

The results of the PIE household surveys indicate that bovines (cattle and buffaloes) are the most important type of livestock in all the projects, and that about 50 to 60 per cent of all households keep bovines in small numbers, primarily as draught animals. Incidence of ownership is related to farm size, about 60 to 75 per cent of marginal and small farmers, and 95-100 per cent of medium and large farmers, keeping bovines as draught animals. The results further indicate that there was no general pattern of difference between Project and control areas in the proportion of bovine owning households. In MDIP there was a higher percentage of bovine owning households in the protected area than in the control area, but in other PIE projects the difference in the percentage of owning households was very small and mostly in the reverse direction (Table 3.6).

The PIE results also show no clear pattern of difference in the size of bovine holding between project and control areas. The number of bovines owned per household was higher in the protected area than in the control area of Chalan Beel D, MDIP and KBK, but lower in Kurigram South and Zilkar Haor. The RRA results showed a trend of reducing livestock numbers over time in Zilkar Haor and Kolabashukhali (Table 3.7), but increases in Kurigram South and Chalan Beel. The results from the two approaches are not necessarily incompatible, since a difference between Project and control may be superimposed on either a rising or falling regional or national trend over time.

The PIE results indicate that ovines (sheep and goats) are important only in Kurigram South and Chalan Beel D projects, where about 40-55 per cent of all households possessed ovines, mainly goats, in small numbers per household. In Zilkar Haor, MDIP and KBK projects ovines are of little importance. However, there are indications that the proportion of ovine owning households was lower in the protected areas of all the PIE projects except KBK. The size of ovine holding was also lower in the protected area of all PIE projects except in KBK. The RRA results for the PIE projects indicate a rising trend in ovine population over time in Chalan Beel and Kurigram South, and no change in KBK (Table 3.7). It is possible that ovine population has increased in all the projects as part of a wider trend of development, but more in the control areas than in the protected areas. At the national level, the goat population has increased by 2-4 per cent annually.

Regarding poultry, the PIE results show that the proportion of poultry owning households was slightly lower in the protected area than in the control area for all 5 projects. However, the size of poultry holding was higher in the protected area than in the control area in Chalan Beel D and KBK, lower in Kurigram South and MDIP, and the same in Zilkar Haor (Table 3.6). At the national level the poultry population has increased by 6 per cent annually. It is anticipated that the poultry population has increased both in the control and protected areas and the projects may have no significant impact on poultry production.

3.6.3 Impacts on Draught Power Requirements

Supply of draught power for land preparation is the most important contribution of livestock in all the projects. PIE results indicate that there were more draught animal units (DAU) per household in the protected area of Chalan Beel D, KBK and MDIP than in their respective control areas, but fewer in the protected areas in Zilkar Haor and Kurigram South (Table 3.6). This difference is related to the difference in the size of bovine holding. PIE results also indicate that, unsurprisingly, the number of DAU/household increases in line with the operational land holding of the household.

From the RRA results, demand for draught power appears to have increased in all the project areas compared with pre-project conditions, and this is confirmed by the PIEs. However, there was a slight overall shortage of draught animal power in the MDIP and KBK. Critical analysis of the data indicates that the draught power requirement was highest in the Aman season and lowest in the Aus season in all the projects, and that medium and large farmers have greatest shortage of draught animals during this period (Table 3.6). To meet the shortage of draught animal power, large farmers have increasingly been using power tillers for land preparation. Both RRA and PIE studies provide clear indications that cows have also been increasingly used for draught power for land preparation.

3.6.4 Spending on Livestock Feeds

The RRA results indicate clearly that livestock feed resources, particularly grazing area and thereby availability of green feedstuffs, have decreased in virtually all the FCD/I projects, due to conversion of fallow and grazing land into cropped land. Moreover, cultivation of pulses has fallen, as these have tended to be replaced by Boro paddy, which has been encouraged by some FCD/I projects.

Paddy straw production, on the contrary, has increased in all the projects except in Nagor River Project where embankment breaches and crop damage are caused by early flash floods. However, both the digestibility and the palatability of straw have declined significantly due to production of HYV rather than LV paddy varieties. With increased paddy production, rice bran production has also increased. However, increased production of rice straw and rice bran do not compensate for the green feedstuff losses caused by the projects.

The PIE results provide some indications that the spending on cattle feeds is higher in the protected area than in the control area in MDIP, Zilkar Haor and KBK projects and lower in Kurigram South, but is the same in Chalan Beel D project. The three projects where spending is higher are those which have had the strongest impacts on crop output, but there is not a straightforward linkage with displacement of grazing areas. Increased spending is disproportionately weighted towards concentrate feeds of high nutritional content, and this probably reflects the greater purchasing power available as a result of increased crop output. As a result of higher feed expenditures, the total cost of livestock production tends also to be higher in the Project than in the control areas.

3.6.5 Income from Livestock

The PIE results indicate that the average income per household from milk production was higher in the protected areas than in the control areas in most of the projects. The RRAs indicate a declining trend in milk production over time, but as noted above this is not necessarily inconsistent with PIE findings. Income from egg production showed no clear pattern of difference between Project and control areas. Net income from livestock was slightly higher in the protected areas in Chalan Beel D, Kurigram South and MDIP but lower in Zilkar Haor and KBK projects.

The overall PIE findings indicate that the impact of the FCD/I project is very variable from project to project, with no clear pattern of overall benefit or disbenefit. The picture from the PIEs is of much more limited impacts on livestock production than had been expected from the RRA results.

Table 3.6 PIE Data on Impacts of FCD/I Projects on Livestock

	Chalan Beel Polder D	Kurigram South	Meghna-Dhonagoda	Zilkar Haor	Kolabashu-khali
1. % Households Owning					
Bovine	↑	↓	↑↑	♦	↓
Ovine	↓	↓	↓↓	↓	↑↑
Poultry	↓	↓	↓	↓	↓
2. Size of Livestock Holding					
Bovine	↑↑	↓↓	↑↑	↓	↑
Ovine	↓	↓	↓↓	↓	↑↑
Poultry	↑↑	↓	↓	♦	↑
3. Draught Power					
DAU/household	↑↑	↓↓	↑↑	↓	↑
Ha/pair DAU	↑	↓	↓	↑	↓
Ha/pair DAU in Aman season	↑	↓	↓	↓	♦
Ha/pair DAU in Aman season by M + L Farms	↑	♦	↑↑	↓	↓
Draught use of cow	♦	↑	↑	♦	♦
4. Spending on Livestock Feeds					
Green roughage/household	♦	↓	↑	↑↑	↑
Dry roughage/household	↓	↓	↑↑	↑	↑↑
Concentrate feeds/household	↑	↓↓	↑↑	↑↑	↑
Total feed cost/household	♦	↓	↑↑	↑↑	↑↑
5. Income from Livestock					
Income from milk/household	↑↑	↑	↑↑	↓	↑
Income from eggs/household	↑	↓	♦	↓	↑
Gross Income/household	↑	↓	↑↑	↑	↓
6. Net Income from Livestock/household	↑	↑	↑	↓	↓

Source: PIE Household Survey Results.

Note: ↑ = Increased; ↓ = Decreased; ♦ = No change; ↑↑ = Substantially increased
↓↓ = Substantially decreased; M = Medium; L = Large

Table 3.7 RRA Data on Impacts of FCD/I Projects on Feed Resources and Livestock Performance

Project No.	Project Name	Change in Livestock Feed				Change in Draught Power Availability				Change in Livestock Population				Change in Milk output	Change in disease incidence
		Grazing Area	Straw Availability		Green forage/ feed	Draught power demand	Draught animal availability	Use of cows	Power tiller use	Cattle and Buffaloes	Goats and Sheep	Chicken	Ducks		
			Quantity	Quality											
1.	Chalan Beel Polder-D	↓	↑	▲ due to HYV	NA	↑	↓	↑	NA	↑	↑	↑	↑	↓	NA
2.	Kurigram Project (South)	↓	↑	▲	↓	↑	↓	NA	NA	↑	↑	↑	↓	↑	↑
3.	Meghna-Dhonagoda	↓	↑	▲	↓	↑	↓	NA	↑	NA	NA	↑	↓	NA	NA
4.	Zilkar Haor	↓	↑	▲	NA	NA	NA	NA	NA	↓	NA	NA	NA	↓	NA
5.	Kolabashukhali	↓	↑	▲	↓	↑	↓	↑	NA	↓	No Change	↑	↓	↓	↑ Parasitic
6.	Protappur	↓	↑	▲	↑	↑	↓	↑	↑	↑	↓	↑	NA	NA	↓ due to vaccination
7.	Nagor River	↓	↓in Lowland ↑in Highland	▲ due to HYV	↓	↑	↓	↑	↑	↓	Seasonal ↑	↑	↑	↓	↑
8.	Sonamukhi	↓	↑	▲	↓	↑	↓	NA	↑	↓	↑ Goats	↑	NA	NA	↓
9.	Sakunia Beel	↓	↑	▲	↓	↑	↓	↑	↑	↓	↑	↑	NA	↓	↑
10.	Silimpur-Karatia	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
11.	Katakhali Khal	↓	↑	▲	NA	↑	↓	↑	↑	↓	↑	↑	↑	↓	NA
12.	Halir Haor	↓	↑	▲	NA	↑	↓	↑	↑	↓	No Change	↑	↑	↓	↑
13.	Kahua-Muhuri	↓	↑	▲	↓	↑	↓	NA	↑	↓	↓	↑	↑	↓	↑ Parasitic infestation
14.	Konapara Embankmnt	↓	↑	NA	↓	↑	↓	↑	↑	↓	↑	↑	NA	↓	
15.	Polder 17/2	↓	↑ in non-gher area	▲	↑	↑	↓	NA	↑	↓	↓	NA	↓	↓	↓ in non-gher, ↑ in gher area
16.	BRE-Kamarjani Reach	↓	↑	▲	↓	↑	↓	↑	↑	↓	↑	↑	↑	↓	↑
17.	BRE- Kazipur Reach	↓	↑	▲	Pulse Prod ↓	NA	NA	NA	NA	↓ Since 1984	↓ Since 1984	↑	NA	↓ Since 1984	↑

Note: ↑ - Increased; ↓ - Decreased; NA - Not Available; ▲ - Deteriorated
Source: RRA Results

3.7 IMPACT ON FISHERIES

3.7.1 General Comments

Growing awareness of the cumulative negative impact of the progression of FCD embankment and polder type projects on inland capture fisheries throughout Bangladesh, and of the general lack of basic information with which to assess the scale of the problem, led to the inclusion of a fisheries component in the terms of reference for FAP 12 RRA and PIE studies.

Seventeen RRA surveys were carried out from late April until mid-July 1991, during the first half of the monsoon flood season when fish production is lowest, whilst the PIEs took place during the peak and the second half of the monsoon, from July to October. This latter period includes the peak time for subsistence floodplain fishing and revival of the beel and river fisheries towards their peaks around November to January. Timing of these studies was dictated by circumstances rather than by choice but from the fisheries side it was advantageous to see conditions during the flood season, despite the added difficulty in contacting fish pond owners and fishermen.

The overall conclusion of the RRA phase was that there were two main areas of fisheries impact, relating to pond fish culture, which usually benefited from FCD, and inland capture fishing, which was almost invariably severely damaged. The pond culture benefits accrued mainly to land owners and farmers, whose land holdings already benefited from positive agricultural impacts, whereas the impact on capture fishing adversely affected large numbers of landless fishermen. The net impact was negative in the very large majority of cases.

PIE coverage was limited to five of the seventeen projects and included interviews with 96 fishermen, 61 pond owners and 18 fish market traders in the five project impacted areas, and 80 fishermen, 20 pond owners and 13 traders in the control areas. Data collection was, perforce, undertaken by non-specialist (albeit well briefed) enumerators who had to cover several disciplines and on the basis of one-off question and answer interviews. There was no opportunity to verify answers, for example, by observing and weighing actual catches, cross checking fish prices with other sellers and buyers or confirming fish pond production rates. Thus the outcome cannot be regarded as other than indicative and in no way obviates the urgent need for more comprehensive resource assessment and studies of aquaculture, capture fisheries technology, production and fish marketing, such as are proposed under FAP 17, and which are the only means by which the present general lack of reliable fisheries data can be rectified.

3.7.2 The Capture Fisheries

Indications from the RRA surveys were that virtually all the projects contributed to the decline in fish stocks for the inland capture fisheries by obstructing fish migration routes, thereby reducing the riverine spawning stocks and preventing the return distribution of fish fry to the floodplains. Land reclamation by drainage works has greatly reduced the areas of permanent water bodies and, especially within FCD/I projects, many formerly perennial beels have been rendered seasonal if not permanently dry. The spawning and rearing areas for numbers of non-migratory, resident floodplain and beel fish species have thereby also been reduced, with similar effects on the stocks of such fish.

Catch rates also declined, with fishermen in several of the RRA project areas claiming reductions of up to 75 per cent, which they blamed in large part on the FCD project concerned. The PIE results include similar findings, with, for example, 76 per cent of impacted area fishermen and 67 per cent of the control area fishermen stating that the project had affected their catches. When asked to compare current and pre-project catch rates, impacted area fishermen seemed worst hit, with 25 of the 96 claiming losses of up to 25 per cent and 56 claiming more than 25 per cent lost catches. The corresponding control area figures were 28 and 36 out of 80 interviews.[1]

RRA findings with regard to submersible embankments, based on studies at Halir Haor and Zilkar Haor, were that they cause less damage to fish stocks because they delay fish migrations to and from the rivers rather than prevent them. The only "submersible" type project in the PIE series was Zilkar Haor, where 65 per cent of project area fishermen claimed losses in excess of 25 per cent compared to 33 per cent from the control area. The figures for all losses up to 25 per cent or more, were 95 per cent for the impacted area against 100 per cent for the control, indicating that the Zilkar fishermen do not consider themselves any better off than fishermen elsewhere (but part of this Project has full flood protection and only part a submersible embankment).

Other significant RRA findings pertaining to the capture fisheries were that:

i. all the projects except for the submersible embankments have greatly reduced the right of free common access to catch fish for subsistence needs during the flood season. The PIE fisheries modules did not contain any specific reference to this aspect, but produced no evidence to the contrary;

ii. virtually all the projects except for the submersible embankments resulted in many former fulltime fishermen having to seek other work, at least on a part time basis. At the same time there was an influx of other landless people into part time fishing for the first time. PIE responses by fishermen and traders identify an increase in total numbers of fishermen, especially in the Kurigram and KBK areas, as a contributory cause of reduced catch rates;

iii. all the projects except for the submersible embankments facilitate the development of enhanced commercial fishing, based on regular restocking of water bodies with hatchery produced fingerlings. PIE responses from fishermen and traders confirm that this is happening, at least in Kurigram, but express doubts that the stranglehold of local elite and wealthy individuals on such fisheries can be broken in favour of fishermen, as is supposed to happen under the New Fisheries Management Policy;

iv. the existing designs of FCD sluices and regulators cannot be operated so as to enable fish to pass in either direction, and conventional fish-ladders are not suited to the needs of local fish species. This was not a matter for PIE study, but as a result of consultation between FAP 12/13 engineers and FAP 12 and FAP 2 fisheries specialists, some tentative new designs have been produced for pilot trial, in the hope that they will prove more effective.

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[1] The questionnaire did not ask for more detailed quantification than up to, or more than, 25 per cent loss or gain

Supplementary results from the PIE findings on capture fisheries are detailed in Appendix J which covers the fisheries sector. Of particular note are the findings on daily catch per fisherman which across the 5 PIEs now averages around 2.5 kg., compared with 4.6 kg. before the projects intervened. Current and pre-project control area averages are both lower than these, partly because impacted area fishermen have a better chance to make up some of their open water losses from catching pond fish for pond owners who lack the means to harvest their own fish. As expected, the great majority of fishermen reported decreases of 25 per cent or more in catches of all the major species groups, namely the major carps, Hilsa, catfish, 'live fish' (Shing, Magur and Koi), and the snake-heads, showing that riverine and floodplain species were equally vulnerable.

Questions in the PIE modules concerning family involvement in fisheries work produced confirmation of the crucial role of wives and children in maintaining the family fishing nets. The responses also showed that many fishermen now spend virtually as much time in fish trading as they do in catching fish, thus confirming an RRA finding from the KBK area in this regard. Further questions about problems currently affecting capture fisheries evoked numerous responses including fishing rights, costs, lack of credit, conflicts with local elites, etc., none of which are project related except for the complaint that boats are now unable to ply in many project areas because of blocked access.

3.7.3 Impacts on Culture Fisheries

RRA findings were that all the projects except for the submersible embankments created improved conditions for expanding and intensifying pond fish culture and culture based fisheries in some other permanent water bodies. However, it was also found that these expected benefits did not occur in parts of some of the projects which were subject to rainwater congestion caused by inadequate drainage provision, or where there were frequent breaches of the embankments. Projects affected in this way included Kurigram, KBK, Nagor River, Sakunia Beel, Kahua-Muhuri and parts of BRE. Even in the areas where flood protection could be maintained, the RRAs concluded that the response by pond owners frequently fell far short of expectations because, so it was said, there was a general lack of credit to finance pond re-excavation and rehabilitation, together with problems stemming from multiple ownership of many ponds and the inability of DOF aquaculture extension staff to meet the needs of prospective fish farmers.

Fish ponds were investigated in four of the PIE study areas, the exception being Zilkar Haor where there were virtually no ponds being cultured because the submersible embankment did not provide the necessary protection and flood depths were too great. In this respect the PIE findings confirmed the earlier RRA conclusion from Halir Haor as well as Zilkar Haor. A total of 61 pond owners were interviewed in the four project impacted areas and 20 from the control areas covering, in total, some 96 ponds measuring about 23 hectares and averaging between 0.1 and 0.2 ha. each. 29 per cent of the project area ponds were single owned compared with 26 per cent in the controls, indicating little or no difference between the two. Abut 50 per cent of pond owners stated that their ponds were dug for fish cultivation but only 6 per cent were actually using the ponds only for rearing fish. The majority were used also for household purposes, such as washing clothes and bathing, 21 per cent were used for livestock washing and watering and 11 per cent served as a water source for irrigation.

Chalan Beel Polder D proved particularly disappointing as regards flood risks. 18 of the 32 pond owners reported that their ponds were regularly flooded prior to project construction, but 12 of them were still at risk despite the embankment, because of breaches, public cuts and rainwater drainage congestion.

PIE findings regarding DOF's extension service were much more favourable than was suggested during the RRA phase. No less than 37 per cent of owners considered that extension has improved, whilst a further 46 per cent thought it was about the same as before. RRA findings in several areas, including Sakunia Beel, Nagor River and BRE, were that extension services were not adequate. Average pond productivity in the Chalan Beel area was disappointing, in line with the continuing flooding problem, and in both project and control areas was less than 700 kg./ha.. Elsewhere production was close to the current national average of about 1400 kg./ha., with the project impacted areas doing slightly better than their respective controls.

Pond owners' views on the reasons for improved performance in the impacted areas included flood protection, higher fish prices, improved availability of good quality fish seed and improved technology, all leading to increased profitability. However, many problems still remain, notably the high risk of fish being affected by the current epidemic of ulcerative syndrome fish disease, the supply of fingerlings still presents difficulty in some parts of the country, and the over-flooding risk is still unacceptably high in places such as Chalan Beel.

3.7.4 Fish Marketing

DOF annual fisheries statistics contain very little information on fish marketing or on the numbers of fish traders and their activities or problems. The RRA studies, especially in MDIP and KBK, found that a number of former full time fishermen had taken up fish trading in addition to, or in place of their catching operations. The PIE findings were that many fishermen were spending at least as much time in trading as they were in catching fish and that as there was also a substantial increase in numbers of traders attending village markets, in several cases by more than 100 per cent, it was highly likely that the two trends were interlinked.

Unfortunately, the number of fish traders who could be interviewed was very small, only one per market in 16 impacted area markets and 13 in the control areas, and it does not appear that there were any part time fishermen/traders amongst them, although a few of the traders said they spend part of their time operating as boatmen. What does emerge is that the quantity of fish handled per trader has decreased, in some cases by up to 60 per cent. Very probably this has been at least partly caused by the increase in numbers of traders, but their responses also show a fall in the daily volume of fish traded at each market. 79 per cent of the traders interviewed considered that fish production had decreased in both the project and control areas, and that the decrease affected all the main species groups.

Most traders considered that the two principal causes of the decline were the blockage of fish migration by FCD structures and the additional fish mortality resulting from fish disease. Other causes included illegal fishing and the excessive capture of fish fry and juveniles.

It proved impossible to obtain credible accounts about fish prices before project implementation from the trader interviews. Current prices compared with published data from 1982/83, suggest increases of 40 to 90 per cent, which is significantly less than has been suggested in other reports. Despite the price rises most traders considered that their incomes and profit have also declined. Other problems affecting the fish trade were identified to include lack of capital/credit and inadequate storage facilities, including the need for increased ice supplies at centres such as Sirajganj, Faridpur and Kurigram.

3.7.5 Conclusion

The combined PIE/RRA findings on FCD impacts on fisheries are summarised in Table 3.8. The principal conclusions arising from the FAP 12 fisheries studies are:

i. there has been a very substantial decline in the freshwater capture fisheries resources and catches, concurrently with the implementation of major parts of the FCD and FCD/I programmes;

ii. despite the general lack of reliable data, the study has established that fish stocks and production overall have fallen by more than 25 per cent in recent years, and in some places the loss may be up to 75 per cent, as reported by many of the fishermen concerned. A major cause of the decline is the blockage of fish migration routes by FCD structures;

iii. consequent on these declining catch rates, there has also been a drop in the number of full time "professional" fishermen, of up to 50 per cent according to RRA reports, coupled with an influx of at least similar numbers of new part time fishermen. These changes are not recorded but the pattern suggests that total fishing effort may not have greatly increased since the late 1980s;

iv. given the reduction in fish stock size, even an unchanged level of fishing effort will cause overfishing, and the present widespread use of illegal small mesh nets only makes matters worse. FCD and illegal overfishing are both implicated in the decline to date, but unless changed or checked, both have the potential to inflict even greater damage in future;

v. among the recommendations for future mitigatory and remedial action, it is proposed that all future FCD projects give particular consideration to fisheries impacts, make appropriate adjustments to structural design and include specific mitigatory provision to assist the fishing communities whose livelihoods will unavoidably be adversely affected. DOF must be fully involved and assisted where necessary to marshal the resources needed. Publicly owned water bodies in project areas should be protected and managed to optimise fish production instead of being drained. Riverine fish breeding stocks should be rebuilt by all possible means, and in particular all existing fisheries regulations governing fish protection must be vigorously enforced.

Table 3.8 FCD/I Project Impacts on Fisheries

Project	Type	Capture Fishery Production			Culture Fishery Production		Fishermen's employment	Fishermen's earnings	Overall Impact	Remarks
		Rivers	Beels	Floodplain	Fish ponds	Larger bodies				
Chalan Beel "D"	P	-2	-2	-2	+1	+1	-2	-2	-2	The loss "leader"
Kurigram South	P	-1	-2	-2	+2	+1	-2	-1	-2	Fish culture OK, otherwise negative
Meghna Dhonagoda	P	-2	-2	-2	+2	+1	-2	-2	-2	Fish culture OK, otherwise negative
Zilkar Haor	S	-1	-1	-1	0	+1	-1	-1	-1	Less damaging to fish stocks
Kolabashukhali	P(T)	-2	-2	-2	+1	+1	-2	-2	-2	Good potential for fish culture
Protappur	P	0	0	0	+1	-	0	0	+1	A neutral project
Nagor River	P	-1	0	0	+1	-	0	0	-1	Without cuts would be -2
Sonamukhi	D	0	-1	0	+2	+1	-1	-1	0	Could improve
Sakunia Beel	P	-2	-2	-1	+1	0	-2	-2	-2	Good potential for aquaculture
Silimpur	E	-1	-2	-2	+1	-	-1	-1	-1	Sandy soil inhibits aquaculture
Katakhali Khal	E	-2	-2	-2	+1	+1	-2	-2	-2	Area no longer a surplus fishery
Halir Haor	S	-1	-1	-1	0	0	0	-1	-1	Less damaging to fish stocks
Kahua-Muhuri	P	-2	-2	-1	+1	+1	-1	-2	-2	Could be improved
Konapara	E	-2	-2	-2	+2	0	-1	-2	-2	Major restocking effort in beels needed
Polder 17/2	P(T)	-2	-2	-1	+1	-1(*)	-2	-2	-2	Shrimp farming needs controlling
BRE-Kamarjani	E	-1	-2	-2	-1	-1	-2	-2	-2	Drainage congestion floods ponds
BRE-Kazipur	E	-1	-2	-1	-2	-1	-2	-2	-2	Erosion of BRE main problem

Source: PIEs and RRAs

Project Type: P=Polder; P(T)= tidal polder; S=Submersible embankments; E=Single embankment, D=Drainage only.

Fisheries Impact: 0=no change; +1=increased by some extent; +2=increased substantially; -1=decreased to some extent; -2=decreased substantially

(*) The area of shrimp farms has reduced since Polder 17/2 completed, so could be rated -2, but remaining area seems stable and with proper control could be expanded for benefit of local small farmers.

3.8 IMPACT ON NON-FARM ECONOMIC ACTIVITIES

3.8.1 Background

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

However, based on the findings of the RRAs and on case studies of rural enterprises made during the PIEs, an attempt has been made to scale the degree of impact the projects have 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), 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.

"Overall impact" is roughly estimated by summing the scores on the ten areas of activity shown in Table 3.9, and ranked as:

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

Table 3.9 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;
Nagor River;
Silimpur-Karatia; and
Halir Haor.

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).

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

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

Intensification of paddy production has usually given rise to mechanised rice milling in the project areas except, perhaps, in few cases where the projects have had limited success in paddy production. In addition, small rice hullers operated with STW engines on a seasonal basis have emerged. Paddy 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 KBK, where there is little scope for irrigation. Silimpur-Karatia is the only case where the number of rice mills has declined. In quite a number of cases, automatic rice boilers have flourished in and around project embankments. With the growth of rice mills, however, the traditional method of rice husking by dheki 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, 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 growth of rice milling and rice trading obviously has linkages with transportation, input supply and engineering workshops, and eventually has increased non-farm employment opportunities.

The increased intensity of cultivation coupled with increased use of mechanised irrigation and cultivation equipment has increased the demand for manufacture and repair of implements. Blacksmiths producing agricultural tools (e.g. spades, weeders, harvesters) have generally increased in number, the working periods of the enterprises have also increased, and slack periods have shortened. Light engineering workshops engaged mainly in repair of irrigation equipment and manufacture of small spare parts for rice mills have shown modest growth.

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 boatbuilding 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.

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 change in living 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 rickshaw/van/cart pulling. The road transport sector is the sector where significant employment generation has taken place for all the projects under study. Nevertheless, on the quite a few projects have had negative impacts on boatmen. However, it is believed that the negative impact on boatmen has 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 employment is generated; in quite a few cases earthworks have provided considerable direct employments to the disadvantaged, including distressed women. In some of the projects, this can be seen as a major impact on non-farm activities.

3.9 IMPACT ON WOMEN'S ACTIVITIES AND GENDER-ROLES

3.9.1 Gender Roles in Field and Home Production

a) Field Crop Production Activities

The traditional gender differences in work in crop cultivation persist in all the project areas. Women are hardly involved in pre-harvest operations of land preparation, sowing and transplantation, irrigation and fertilizer application. A similar situation obtains in the case of harvesting. It is almost exclusively a man's job, with the solitary exception of the Chalan Beel impacted area where Saouthal women join as wage labour during harvesting and for transporting paddy.

Threshing is done by both men and women (including hired women). Drying and parboiling of paddy is almost exclusively a women's job in which both family members and hired hands are involved.

Table 3.9 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 D	+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

Husking of paddy previously used to be almost exclusively a women's job, but is no longer so (Table 3.10). The widespread use of STW engines for rice husking has allowed women to be free to a degree from this back-breaking chore. It is the men, however, who take the paddy to the place outside the homestead for husking. As a result, women are reporting men to be involved more than before in rice-husking. One exception is in the Meghna-Dhonagoda impacted area, which depends largely on canal irrigation, and consequently does not have STW engines which can be reallocated to husking mills. Hence, although people there have husked rice in mills since before the project, and men were thus already involved, there is little change in the relative gender roles in this activity. In the Meghna-Dhonagoda control area, however, STWs are used for irrigation and also for rice-husking. As a result, there has been a substantial increase of involvement of men in rice-husking.

Kolabashukhali is the only area where the traditional burden on women of husking still remains. This is due to the fact that there are hardly any mechanical husking facilities in the area, which has few STWs due to unsuitable conditions for groundwater irrigation. Although the town of Khulna is not far away, communications are too difficult to take paddy there for milling.

None of these changes, however, can be attributed entirely to the project interventions because the widespread use of shallow tubewells is not an impact of the projects except in those cases where FCD gives protection to the Boro crop.

b) Tree Plantation and Homestead Gardening

In all the projects, irrespective of the division between impacted and control areas, women have a large role in decision making regarding plantation of trees but most decisions are made jointly with men. The same may be said of harvesting the trees for fruits. However, men almost exclusively preserve the right for decisions regarding felling of trees.

In the case of actual division of labour, women are almost exclusively employed only in collection of fuelwood and leaves. In all other cases they mostly share the tasks with men. Tree-felling again is a man's job.

In homestead gardening, women predominate both in decision-making and in actual use of labour. Men, however, substantially control the actual sales made as it is they who generally take the fruit or other produce to the village market.

3.9.2 Impact of the Project on Women's Workload

a) Agricultural Work

Women are mainly involved in seed preservation and in post-harvest processing (mainly threshing and parboiling). Their involvement in seed preservation has generally increased in the impacted areas and has either decreased or remained unchanged in the control areas. The situation regarding threshing is not clear, though it should be noted that threshing is largely a man's job.

The trend in parboiling is also not clear. While a substantial number of respondents stated that this aspect of their workload has increased, a significant number have said it has decreased. Husking by women has generally decreased everywhere.

Table 3.10 **Change in Sex-Roles in Husking of Paddy**
(% of farm households responding)

Project	Type of area	Family women		Hired women		Men	
		Before	After	Before	After	Before	After
Zilkar Haor	Impacted	59	44	14	9	6	24
	Control	70	63	7	7	17	30
Chalan Beel Polder D	Impacted	52	32	3	5	2	19
	Control	69	68	3	3	-	24
Kolabashukhali	Impacted	90	87	8	8	5	11
	Control	80	77	-	-	-	-
Kurigram South	Impacted	92	82	18	10	11	32
	Control	86	81	24	24	22	43
Meghna-Dhonagoda	Impacted	74	68	25	3	33	39
	Control	83	43	-	-	47	87

Note: The same respondent may have given more than one answer

Source: PIE surveys

Whenever women have stated certain activities to have increased, the general reason behind the change is put forward as higher output, either because of increased yield or higher cropping intensity or both. The reasons behind a decrease in activities are generally stated to be related to adverse hydrological phenomena such as floods, water logging or excessive rains. Loss of land (due to erosion or distress sale) also sometimes features prominently in women's responses. The prevalence of husking mills is reported by women to be the reason for the lower burden of husking.

b) Non-agricultural Work

Women are not involved to a great extent in non-agricultural activities. Furthermore there appears to be little difference between the impacted and control areas in their incidence.

3.9.3 Home Production and Related Activities

Vegetable gardening is almost universal, but on the average the area of land involved is very small, no more than 0.01 acre in many cases. Poultry keeping is also quite widespread. In neither case does there appear to be an appreciable difference between the impacted and control areas. The average implication in terms of income (the value of production) per household does not appear to be more than Tk.1000 per year.

3.9.4 Nutritional Issues

A rise in the 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, FAP 12 tried to find out the perception of the women regarding the adequacy of food intake in the family. As rice and wheat constitute the major source of nutrition[1], women were asked if the intake in the family was adequate.

Table 3.11 Adequacy and Gender Differences in Food Intake

Indicators	Project	Farmer		Labourer		Fishermen	
		Impacted	Control	Impacted	Control	Impacted	Control
% 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
Female:male 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: PIE surveys

The answers reported in Table 3.11 show that:

- there is no systematic difference between the impacted and control area;
- there is no appreciable difference among projects (except perhaps for Kurigram which reports the maximum incidence of inadequacy); and
- the labour households appear to be the most disadvantaged group.

Two indicators of gender differences were used: the difference in rice intake of adult men and women, and that between boys and girls of about 8 years of age. The latter showed little difference in food intake which mostly hovered around 5-6 *chhataks* (290-350 grammes). In contrast, there is an appreciable difference between the intake of adult men and adult

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[1] The estimated proportion of energy from these two are just about 80 per cent as reported in the most recent Household Expenditure Survey (BBS 1991).

women, the latter being found to consume about 25 - 30 per cent less than men. There is little variation between impacted and control areas within PIE study areas, or between projects.

3.9.5 Problems Faced by Women Due to Floods

Women were asked questions on the problems of the household due to flood, and which problems affected women most adversely. The replies given by them as reproduced in Table 3.12 indicate the types of major problems faced by women. These are:

- lack of dry space;
- drinking water availability;
- sanitary problems;
- food availability and cooking; 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 among occupational groups (for which reason the answers have been grouped together).

Table 3.12 Problems Faced by Women During Floods

Types of problems	Chalan Beel Polder D		Kurigram		MDIP		Zilkar Haor		Kolabashukhali	
	Imp.	Cont.	Imp.	Cont.	Imp.	Cont.	Imp.	Cont.	Imp.	Cont.
Dry space	19	7	28	23	52	80	65	46	17	34
Drinking 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: PIE surveys

Note: Imp. = Impacted Area
Cont. = Control Area

3.10 SOCIO-ECONOMIC IMPACTS

3.10.1 Social Objectives

The projects studied generally had no explicit objectives related to social development or income distribution targets. In some cases it was expected that increased agricultural production and hence increased employment and incomes would result in socio-economic benefits, and in Polder 17/2 the closure was designed to eliminate shrimp farming which was regarded as a social evil.

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. The social impacts of the studied projects are summarized in Table 3.13 and discussed below.

3.10.2 Occupations and Employment

Project construction created short term employment for labourers. There is little routine maintenance. Instead, repair and rehabilitation of embankments create periodic direct employment which to some extent helps labourers who might not otherwise benefit.

In projects which have resulted in an increase in monsoon rice production this has generated modest increases in employment for both family and hired labour for both men (agricultural labour) and women (paddy processing). Where the area under Boro cultivation has increased due to FCD/I projects there has been a substantial increase in employment (MDIP). In most projects the pattern of seasonal migration of labour is little changed, but some projects (Halir Haor) have clearly promoted in-migration at peak periods. Out-migration is not, however, reduced at slack periods. In MDIP there has been some permanent in-migration attracted by employment and security from floods.

There have been few occupational changes for the majority of FCD/I project inhabitants (farmers and labourers in all PIEs). Almost all the projects (perhaps with the exception of submersible embankments) showed disbenefits in terms of reduced employment for fishermen, and in several projects fishermen 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. 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 part of the project (KBK). Improved communications have facilitated government and non-government development activities, which have generated additional employment and income for poorer sections of the population, but it is difficult to discern any difference from unprotected areas. In Zilkar Haor, where the level of inundation decreased and internal road communications improved, there has been an increase in school enrolment, especially in the wet season.

3.10.3 Income Distribution

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 differences between project impacted and control areas.

In general no significant differences were found between project and control areas in the incomes of the landless and near-landless. However, the larger landowners (and richer households) have higher per capita incomes in projects where there have been sizeable increases in crop production. For example, there is no significant difference in per capita incomes of different landholding classes between Chalan Beel Polder D and its control area (and little difference in agricultural productivity). However, in Zilkar Haor larger landowners have clearly benefited, and particularly in those years when early floods occur (as in the study year), and in Kolabashukhali it appears that both the landless and large landowners are better off relative to the control area.

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 in 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 because of annual repairs of damage caused during submergence.

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 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).

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. However, no instances of social conflicts were reported in this regard.

In the PIEs inhabitants of the project impacted area confirmed these results, reporting that fishermen, outsiders, and boatmen had in general been disadvantaged most. These groups, plus those losing land, had opposed the projects, whereas larger landowners, local influentials, and local UP and Upazila representatives had supported the projects. However, in most cases BWDB took the major initiative in launching projects.

3.10.4 Landholdings and Land Acquisition

Land is the major rural asset, and in the PIEs an indication of changes in landholding was obtained. In projects which provide significant agricultural benefits (Zilkar Haor) more changes in landholding, and more increases in holding, were reported inside the projects compared with control areas during the post-project period; the pattern is unclear where there was relatively little difference in agricultural impact between project and control areas but again greater mobility in holding class may occur inside the projects (Chalan Beel).

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. Also 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.

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. In two Projects (MDIP and Kolabashukhali) over 20 per cent of households in the impacted area appeared to have lost land to the project infrastructure. 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 of those whose land was acquired (particularly in Kurigram). Those who paid bribes did not appear to receive better prices or faster compensation.

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. At BRE Kazipur delays in paying compensation delayed the construction of the retired embankment, seriously affecting the quality of work.

A further problem relates to the long delay in transfer of land title by BWDB after payment of compensation. In Kurigram some farmers continued to be charged land taxes for years after their land had been occupied by an embankment. A transfer of title will be necessary if BWDB is to create use rights to the public infrastructure.

3.10.5 Local Participation and Social Conflict

In general, local people were not consulted at any stage of project planning or construction. As a result local knowledge about the physical and social features of the project area could not be utilized. 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 try to prevent construction. Although the projects were generally initiated by BWDB and supported by the local influentials and larger farmers, there was general agreement in the PIE studies that landless labourers had also benefited from the projects.

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 perceived the positive benefits of the embankment, the local people 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 were 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 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;

- 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.

3.10.6 Flood Impacts

Apart from submersible embankments, FCD/I projects are intended to provide protection from flooding to property and infrastructure. This has happened in some projects (Polder 17/2), but in many a false sense of security appears to develop. Flooding has occurred inside most of the projects since their completion (either through embankment failures, cuts or greater than design standard events). In the most recent extreme floods the PIEs failed to show any difference in the incidence of property damage between project and control areas; indeed, average damages (to households and rural businesses) tended to be **higher** in the project areas - this could reflect increased wealth in some projects, or settlement on lands which would have been regarded as too risky had there been no project, or the decline of previous household adjustments to flood risk. Crop damage was reportedly less in 1987 and 1988 in three of the PIE projects (compared with control areas), but was greater in Chalan Beel and MDIP which suffered breaches (and cuts in Chalan Beel) in both these years.

Where FCD/I projects have undoubtedly provided benefits in high floods is in embankments acting as flood shelters/refuges (about half the projects studied). 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 certainly undermines the quality of the embankments. In some cases such as BRE, the embankment should be designed for this 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 these 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.

3.10.7 Quality of life

If FCD/I projects lead to increased agricultural output, this might result in investments in improved houses or tubewells, for example, and hence a better quality of life. PIE data indicated that in some projects where there have been economic gains fewer houses were in bad condition and that more were of pucca construction (Zilkar Haor). Although there has been an increase in the availability of tubewell water for drinking this does not differ between project and control areas. There is no evidence that in the PIE projects households invest more in education than they do in the control areas.

Nutritional status is difficult to assess. However, the PIEs indicated little noticeable difference in the seasonal or overall incidence of food shortages between project and control areas. If food grain production has risen but per capita consumption is not noticeably changed this suggests that the benefits have been restricted to a few wealthier households, with population growth eating away the remaining benefit.

Nutritional status, particularly for the poor, also appears to be adversely affected by the declining availability of fish in almost all the projects. Availability of other animal protein may be little different between project and non-project areas, while replacement of pulses by paddy is a project impact in some cases (MDIP) and results in greater dependence on purchased foods.

Table 3.13 Summary of Socio-Economic Impacts

Name of Project	Employment Opportunity	Transport Trading & Facilities	Seasonal Labour migration		Conflict of interest/ dis-satis-faction	Dis-benefitted Groups	Outside Farmers Disbenefit	Fishermen Disbenefit	Boatmen Disbenefit	Peak Flood Damage to Property	Embankment as Flood Shelter	Induced Development Activities
			Out-Migration	In-Migration								
Chalan Beel	+1	+1	+1	+1	0	+1	+2	+2	+1	+2	0	+1
Kurigram	+1	+1	-1	0	+1	+1	+1	+1	+1	-1	+2	+1
Meghna-Dhonagoda	+1	+2	-1	0	+1	+1	+1	+2	+2	0	+1	0
Zilkar Haor	+1	+2	-1	0	0	+1	0	+1	+2	-1	+1	+1
Kolabashukhali	+1	+1	+1	0	0	+1	0	+2	+1	-2	0	0
Protappur	+1	+1	0	+1	+1	0	0	0	0	0	0	0
Nagor River	+1	+1	0	+1	+2	0	+2	0	0	0	+1	+1
Sonamukhi	+1	+1	0	+2	+2	0	+1	+1	0	0	0	+1
Sakunia Beel	+1	+1	0	+1	+1	+1	0	+2	+1	0	+1	+1
Silimpur-Karatia	+1	+1	0	0	+2	+1	0	0	+2	0	0	+1
Katakhali Khal	+1	+1	+2	0	0	+1	0	+2	+1	0	+2	0
Halir Haor	+1	+1	+1	-1	+1	0	0	0	0	0	0	0
Kahua-Muhuri	+1	0	+1	+2	0	+1	0	+1	0	-1	0	0
Konapara	+1	+1	-1	0	+2	+1	+2	+1	0	-1	0	0
Polder 17/2	+1	+1	0	0	+2	+1	0	+2	+1	-2	+1	+1
BRE-Kamarjani	+1	+1	+1	0	+1	+2	+1	+2	0	-1	+2	+1
BRE-Kazipur	+1	0	+1	+1	+1	+2	+1	+2	0	0	+2	+1

Notes: 0 = No Change; +1 = Increased to some extent; +2 = Increased substantially;
-1 = Decreased to some extent; -2 = Decreased substantially

Source: PIEs and RRAs

3.11 ENVIRONMENTAL EVALUATION

The approach to environmental evaluation is detailed in the FAP 12 Methodology Report and summarised in Section 2.5.1 of this report. The environmental issues identified as potentially significant for FCD/I projects in Bangladesh are presented in Tables 3.14 - 3.16. Environmental evaluation of these issues is briefly summarised below, although clearly there are many variations between the 17 different FAP 12 study areas. More emphasis is given to the ecological issues (i.e. physical and biological) than to human issues, which are more intensively covered by the FAP 12 socio-economic studies.

3.11.1 Physical Environmental Issues

a) River Flow

The FAP 12 study areas do not usually include active rivers within the impacted project area, so that river issues usually relate only to the external impact areas. As noted in Section 2.5., impacts on river issues represent the cumulative effects of the project plus similar projects within the river basin, where these occur. In some areas, the sheer size of the adjacent river precludes any significant project impact upon it. Khals, "dead" rivers and old cut-off channels are considered with wetlands and waterbodies in (f) below.

Where cumulative impacts are identified, river flows usually increase due to containment between or against embankments. This is a less marked negative impact in projects assessed in isolation.

b) River Quality

The potential key parameters are sewage, agrochemicals, sediment load and salinity. Increased use of agrochemicals and possibly increases in indiscriminate sewage might pollute rivers via drainage effluent, although the current lack of data prevents this negative impact being accurately assessed or demonstrated. Increases in river sediment load or salinity do not seem to occur due to the projects.

Table 3.14 Physical Environmental Issues

WATER	LAND
a. River Flow	a. Soil Fertility
b. River Quality	b. Soil Physical Characteristics
c. River Morphology	c. Soil Moisture Status
d. Flooding and Drainage	d. Soil Erosion
e. Groundwater Levels/Recharge	e. Soil Salinity
f. Groundwater Quality	f. Land Capability
g. Wetlands and Waterbodies Extent/Recharge	g. Land Availability
h. Wetlands and Waterbodies Quality	

Table 3.15 Biological Environmental Issues

FAUNA	FLORA
a. Bird Communities/Habitats	a. Trees
b. Fish Communities/Habitats	b. Other Terrestrial Vegetation
c. Other Macro-fauna Communities/Habitats	c. Aquatic Vegetation
d. Micro-fauna Communities/Habitats	

c) River Morphology

Key parameters are bank erosion, bed scour and siltation. All three are induced by river containment by embankments and are usually most significant as negative impacts where there is a cumulative project effect.

d) Flooding and Drainage

These have been assessed jointly because of the difficulty of separating the impacts upon them. Together they constitute the single most important primary environmental impact. Key parameters are the level, timing, rate of rise, duration and extent of floods.

Most projects have achieved considerable positive impacts on flooding in terms of one or more of these parameters. However, where embankments have failed and/or are unwisely located (Kurigram South, MDIP), a high risk factor may apply. In addition, monsoon season inundation due to rainwater congestion continues to occur. In most projects, there are drainage inadequacies which to varying degrees negate the positive impacts on flooding.

Negative off-site flooding impacts, caused by containment of river flows, are typical in the external areas.

e) Groundwater

Groundwater levels and recharge are sometimes claimed to be lowered by exclusion of floods. However, regional recharge is so great in Bangladesh that only temporary seasonal impacts are likely, if any.

Groundwater quality is a more serious consideration. The same remarks apply as in (b) above, as potential key parameters are again agrochemicals, sewage and salinity. Lack of data is a basic problem. Negative impacts here could be a problem in several projects where HYV have greatly increased, especially where soils are also permeable (e.g. MDIP).

f) Wetlands and Waterbodies

Wetlands are the seasonally or perennially flooded areas which are too wet even for B. Aman rice, while waterbodies include khals, "dead" rivers, old cut-off channels, etc.

The extent and recharge of wetlands are usually greatly reduced by the projects selected for study by FAP 12, due to flood control and drainage. This, from a wetlands viewpoint, is evaluated as a negative impact, despite leading to a variety of positive human impacts.

Wetlands quality is subject to the same comments regarding key parameters and lack of data as in (b) and (e). Significant negative impacts are assumed in some projects (e.g. MDIP) but are impossible to demonstrate without data.

g) Soil Characteristics

Soil fertility decline is almost universally alleged by farmers as a result of flood control excluding river silt from their fields. This is not thought to be a significant impact, although some limited fertility decline does seem to occur (although again there are insufficient data

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to illustrate or quantify it). The likely cause seems to be the loss of aquatic vegetation and the micro-biota, including the nitrogenous blue-green algae, which thrive on it. This impact occurs where wetlands are reduced in size and duration of inundation, and also to a lesser extent where B. Aman is replaced by T. Aman, especially HYV. This impact, therefore, is a widespread but minor negative effect throughout most study areas. It is relatively unimportant because natural levels of soil fertility alone are inadequate to sustain intensive cultivation.

Soil physical characteristics suffer negative effects in project areas when sand deposition results from embankment breaches (e.g. Nagor Valley, MDIP). Minor impacts may also occur due to sand deposition by the increased flooding in external areas (e.g. MDIP). In areas with dominantly sandy soils, the loss of silt deposition also constitutes a negative impact, preventing the build-up of silty topsoils (Kurigram South, MDIP).

Soil moisture status usually improves over much of a project area due to flood protection and drainage, although ridges in the generally ridge-and-basin terrain of the study areas may suffer a minor negative impact due to rapid drying-out in the rabi season (Chalan Beel D). In the external areas, increased flooding keeps soils wetter longer.

Soil salinity is rarely a significant issue, as most areas have high rainfall and internal flooding or irrigation, so that leaching far outweighs any accumulation. Tidal areas were affected by saline water but this is usually now excluded by projects (Kolabashukhali), unless saline water is required for shrimp culture (Polder 17/2) when residual salinity may limit the yield of subsequent paddy crops.

Acid sulphate soils may occur in one or two projects (e.g. Kolabashukhali) but are unlikely to be extensive. If drained, the negative impact is excessive, due to production of free sulphuric acid. In Kolabashukhali the less extreme impact of acidification of drained peat soils is a more significant negative impact.

h) Micro-relief

The only area where this may suffer an impact is again in Kolabashukhali, if shrinkage of reclaimed peat soils occurs.

i) Land Capability and Availability

Land capability is almost always substantially improved by FCD/I projects, through reduction of flood hazard and increased cropping security and flexibility. Occasionally, the loss of other enterprises, such as fishing and/or livestock grazing, to gain wetlands of doubtful suitability for cultivation may minimise or even outweigh this positive impact (e.g. reclamation of peat beels in Kolabashukhali).

More land often becomes available. This may be limited in extent (Kurigram, MDIP) or extensive (Kolabashukhali, Chalan Beel D). In places, in some low-lying AEDs, land is actually lost, due to inadequate drainage (e.g. AED C in Zilkar Haor, AED D in Kurigram South).

3.11.2 Biological Environmental Impacts

Any attempt to assess the biological impacts of projects has to take account of parallel trends that were initiated long before such projects were conceived (Section 2.5.1). These are essentially the trends associated with the accelerated increase in population pressure both on the physical resources which provide biotic habitats and on the biotic communities themselves. Cultivation, land settlement, vegetation clearance, hunting and fishing have all increased in the study areas as population density has soared over the last few decades.

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

A basic problem in evaluating impacts of either population growth or the impact of FCD/I projects on biotic issues is the total lack of any data from any previous points in time. There is a general claim that at some ill-defined time in the past, birds, fish and other wildlife flourished in large numbers, but no quantified baselines exist, either now or for any previous time. The only broad numerical data available relate to fish catches in some areas.

a) Fauna

Only one or two study areas are likely to have had significant natural wildlife, other than fish and aquatic micro-fauna. Birdlife, and especially waterbirds, is the most critical issue, because of the importance of Bangladesh's wetlands in the international migration routes. Only Kolabashukhali and Halir Haor might have had substantial bird populations pre-project. The only macro-fauna to flourish due to the projects seem to be rats, which welcome the embankment as a home and the extra crops as food, and possibly snakes, which often live in disused rat-holes and feed on rats.

With the limitation or destruction of the wetlands, and with the interruption of migration and breeding, fish communities and habitats have undoubtedly suffered significant negative impacts due to the projects. However, these are often exaggerated, as fish populations and biodiversity are already under pressure from intensive overfishing everywhere and, since 1988, from the ulcerative fish disease which has swept the country.

b) Flora

Apart from aquatic vegetation, virtually no natural vegetation existed pre-project, and impacts on terrestrial vegetation have therefore been negligible. Aquatic vegetation has suffered negative impacts where wetlands have been significantly reduced or modified, or possibly polluted - see Section 3.11.1 (f).

It is just possible that Kolabashukhali (along with the other projects in the western delta region) has a cumulative slight positive impact on freshwater entering the Sundarbans, by restricting the spreading and evaporation of water before it reaches the coast.

3.11.3 Human Environmental Impacts

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

Many of the human issues are covered in detail in other sections of this chapter. They can be conveniently grouped into five sub-categories: human use, social, economic, institutional, and cultural issues. Consideration of the human impacts in terms of the different AEDs and external areas provides an additional distributional perspective to the more detailed discussions elsewhere in the report.

a) Human Use

The various human use issues are listed in Table 3.16. Crop cultivation, including irrigation, is easily the major positive human use impact in most projects. FCD often increases crop area, crop security and crop flexibility, as well as the opportunity for dry-season rice irrigation by preventing early flooding.

Against this, livestock and capture fisheries usually suffer negative impacts. Livestock are less affected, but grazing around seasonal wetlands and green fodder crops and residues are often lost under FCD. Fish ecological impacts have been discussed above, with obvious negative implications for capture fisheries (although again it is easy to exaggerate, as capture fisheries everywhere are declining). Culture fisheries, on the other hand, are encouraged because ponds are protected from wash-out and stock loss.

Afforestation and tree-planting have been slow to take advantage of the increased opportunities offered by FCD, not least on the embankments themselves. In some projects where FCD is effective there is an increase in homestead gardens of tree species intolerant of excess water (Kolabashukhali).

Agro-industrial activities benefit because of the increased agricultural production and input requirements. Road communication and access are improved, if only by the embankment itself; many areas, however, remain with poor communications (MDIP, much of Kolabashukhali).

Infrastructural impacts are typically positive due to the protection from annual floods. However, embankment failure and public cuts leading to catastrophic flooding can reverse this (MDIP, Nagor River) or remain a high risk (Chalan Beel D, Kurigram South).

Domestic water supply is rarely obviously affected, although the same comments apply as for groundwater (and surface water) quality in Section 3.11.1 (e) and (f).

Sanitation could suffer negative impacts due to prevention of the flushing-out of indiscriminate sewage by seasonal floods that occurred pre-project. However, no data exist and the impression is that awareness of the problem and increased use of latrines probably minimise any impact.

Recreation and energy rarely receive significant impacts due to FCD. Recreational activities are generally limited and energy impacts are only identified where energy is wasted or conserved or created.

b) Social Impacts

The generally substantial positive impact on human carrying capacity is the main consideration here. Demographic levels and structure usually benefit slightly due to slow-down (Kolabashukhali) or even reversal (MDIP, Zilkar Haor) of out-migration.

Gender and age issues are not greatly affected, although women may sometimes benefit from increased employment opportunities.

Health and nutrition usually receive minor positive impacts due to substantially increased food production, reduced slightly by reduced fish and/or livestock protein and less varied crops.

Frequent disruption is almost always greatly reduced and in some cases personal safety is also increased. However, embankment failure leading to catastrophic flooding can reverse such impacts (MDIP) and risk can again be a factor (Kurigram South).

Land ownership usually suffers a minor negative impact, due to land acquisition for the embankment and other project works. This may be exacerbated by inadequate compensation.

Project benefits inevitably go more to the better-off and least of all to the landless and displaced fishermen. However, impacts are usually distributed approximately proportionally to the economic status quo, so that impacts, viewed pragmatically, are not very significant.

Social cohesion suffers slightly where disputes between farmer and fishermen (Zilkar Haor) or between residents inside and outside the bund occur (Chalan Beel D). Social attitudes, however, are almost always substantially in favour of the Project, despite a plethora of complaints.

c) Economic Impacts

Incomes, employment, land values and credit availability all generally improve significantly, reflecting the increased agricultural productivity. The people, on the whole, receive substantial positive economic impacts, partly because they contribute little to project costs.

d) Institutional Impacts

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

Institutional activity and effectiveness are usually found to be inadequate, although the lack of resources is partly to blame. Many of the problems formerly of planning, design and construction and currently of operation and maintenance relate to this.

Public participation varies but is usually poor or non-existent. Considerable improvements in operation and maintenance could be achieved by correcting this.

e) Cultural Impacts

Very few sites of cultural importance were encountered in the study areas. Scenic quality was never felt to be significantly impaired. Cultural continuity suffers in some places because of the demise of the usually Hindu traditional fishing community and way of life. Overall quality of life invariably improves because of the reduced threat of flooding and the increased food supply and economic well-being.

Table 3.16 Human Environmental Issues

HUMAN USE
a. Crop Cultivation (inc. irrigation)
b. Livestock
c. Capture Fisheries
d. Culture Fisheries
e. Afforestation
f. Agro-industrial Activities
g. Transport Communications
h. Infrastructure
i. Domestic Water Supply
j. Sanitation
k. Recreation
l. Energy

SOCIAL
a. Human Carrying Capacity
b. Demography
c. Gender
d. Age
e. Health and Nutrition
f. Disruption, Safety and Survival
g. Land Ownership
h. Equity
i. Social Cohesion
j. Social Attitudes

ECONOMIC
a. Incomes
b. Employment
c. Land Values
d. Credit Availability

INSTITUTIONAL
a. Institutional Activity/Effectiveness
b. Public Participation

CULTURAL
a. Historical/Archaeological Sites
b. Cultural Continuity
c. Aesthetics
d. Lifestyle (Quality of life)

3.12 ECONOMIC RE-EVALUATIONS

3.12.1 Introduction

Flood control projects are assessed in terms of the economic contributions that they are expected to make, before an investment decision is finalised. This usually means undertaking a technical-economic feasibility study and the estimation of a summary statistic such as the BCR, the NPV or the IRR. Typically however, feasibility studies have been based on the net impact on crop (paddy) production. Possible project economic impacts on fisheries, livestock, navigation, or downstream impacts outside the project, are almost never taken into account.

3.12.2 Approach

Seventeen post evaluations were carried out, of which 12 were based on RRA findings, while 5 were based on PIE data. These evaluations took into account both agricultural and fisheries impacts (typically benefit and disbenefit, respectively) in arriving at conclusions. Clearly there are other impacts as well that could have a bearing on project success or failure, for example impacts on navigation, transport and the environment. These impacts could not, however, be taken into account explicitly.

It is important to note the differences between PIE and RRA economic post-evaluations. In the RRAs the economic summary statistics are indicative of the economic return, but should not be regarded as definitive. For example, agricultural changes were estimated on the basis of before-after comparisons (using recall) and an assessment of what might have happened without the project, while fisheries impacts were often estimated on the basis of scanty data. In the PIEs the estimates of economic return are based on a with-without comparison using control areas, and should be more reliable, at least so far as agricultural impacts are concerned. The estimates are of course dependent on how similar the control areas are to conditions in the projects before completion, but fortunately they appear generally to be good matches. In the case of fisheries, in the PIEs some allowance has also been made for the impacts of projects on fish stocks in adjacent rivers.

In the individual RRAs and PIEs, sensitivity analyses have been undertaken with respect to some of the key assumptions and factors. Some projects proved sensitive to relatively small changes in key parameters, particularly Aman yields (BRE, Kurigram) while others were much more robust (Halir Haor, Katakhali Khal). The cash flows are also dependent on assumptions regarding the 'take up' or phasing of project impacts. Because it investigated completed projects in order to understand their full impacts, FAP 12 could not investigate in detail the transition phase upon completion, and had to rely on local recall in the RRAs, project documents (if available) and common sense. The FPCO (1991) recommendations on take up were followed when there was no local information to provide better indications.

While construction costs were usually quite well documented, it was not always possible to obtain a sufficiently detailed breakdown for economic pricing, in which case standard breakdowns from BWDB were used. O&M cost estimates reflect current practice, but are sometimes based on scanty or incomplete data.

Wherever possible, the actual performance of the projects has been the guide to their impacts, and this has included 'failures' during the project life to date. However, estimation of the risk of failure for the remaining project life is very difficult in projects which have not failed, and has not been allowed for. Where a project is regularly cut or breached the net benefits reflect these normal circumstances, and in general the performance over the project's life to date has been assumed to hold for the remainder of its life.

3.12.3 Broad Findings

Table 3.17 lists the projects studied and presents comparable figures on capital and O&M costs, agricultural benefits, fisheries losses, the EIRR and period of implementation of projects. Out of 12 projects studied by RRA, only six were assessed as economically viable (EIRR over 12 per cent), while of the 5 projects studied by PIE, 3 were assessed as viable. For two of the PIE projects where the preliminary RRA estimated an EIRR, the economic assessments from the two methods were in broad agreement: EIRR for MDIP was estimated to be 7.3 per cent by PIE and 5 per cent by RRA, while EIRR for KBK was estimated to be 17 per cent by RRA and 24 per cent by PIE.

Certain broad conclusions emerge quite clearly.

i. There is a striking inverse relationship between the EIRR and the period of project implementation (exceptions are Nagor River and Silimpur-Karatia projects) (Figure 3.1).

ii. Projects with a high EIRR (over 30 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 3.2). 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 25 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 also quite respectable, although the results are very sensitive to small changes in yields.

iii. Capital costs per hectare are small (compared to international standards). They do not seem to vary greatly from project to project, and EIRR is not very closely related to the level of costs (Figure 3.3). The exception is Meghna-Dhonagoda Irrigation Project, where costs have been extraordinarily high (Tk.129,000 per benefited hectare), so that even the relatively high benefits failed to yield an acceptable EIRR. Generally costs per hectare ranged from Tk 3000 to Tk 18000.

iv. Annual 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/ha.. As a proportion of capital costs O&M costs typically average around 3 to 5 per cent, a figure which is higher than generally assumed in feasibility studies.

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

vi. For projects in the normal range of capital and operating costs, EIRR is very strongly correlated with the level of net benefits to agriculture and fisheries (Figure 3.4). Good EIRRs (over 20 per cent) are associated with agricultural benefits, net of fisheries losses, of over Tk.2000 per hectare. At typical levels of fisheries losses, this implies agricultural benefits alone of at least Tk.3000/ha.. The exception again is Meghna-Dhonagoda, which has the highest net benefit of any project studied (over Tk.13,400/ha.) but can only achieve an EIRR of 6.7 per cent due to its enormous capital and O&M costs.

Table 3.17 **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 (%)	Implementation 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 (all)	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.

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Figure 3.1 EIRR and Implementation Period
(negative EIRRS indicative only)

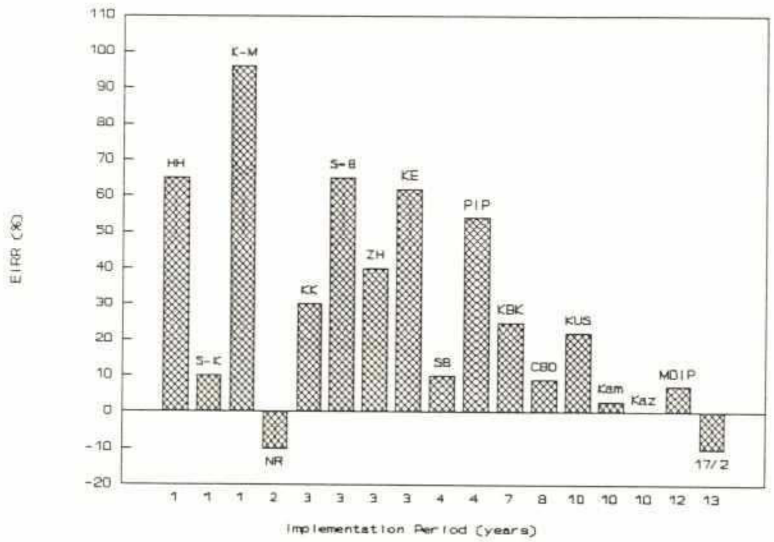
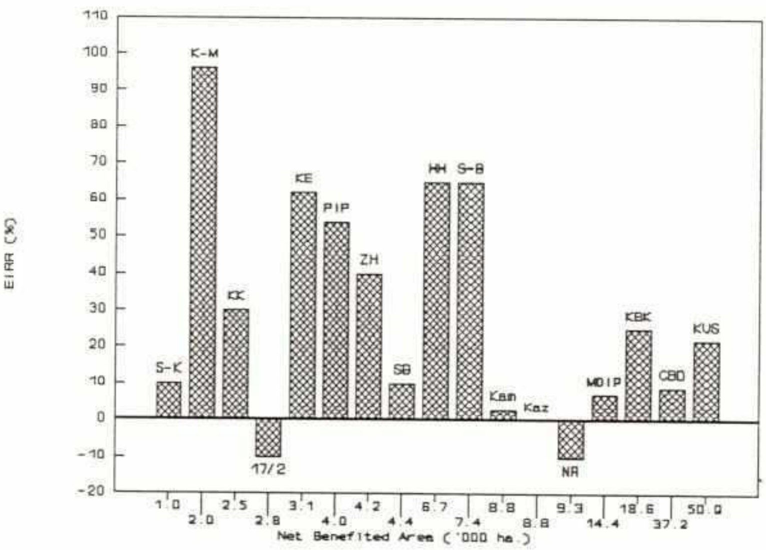


Figure 3.2 EIRR and Net Benefited Area
(negative EIRRS indicative only)



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 3.3 EIRR and Capital Cost
(negative EIRRS indicative only)

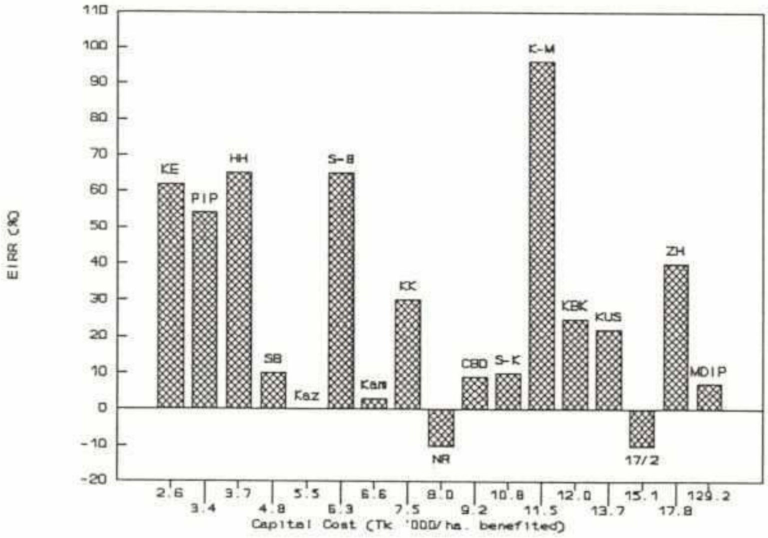
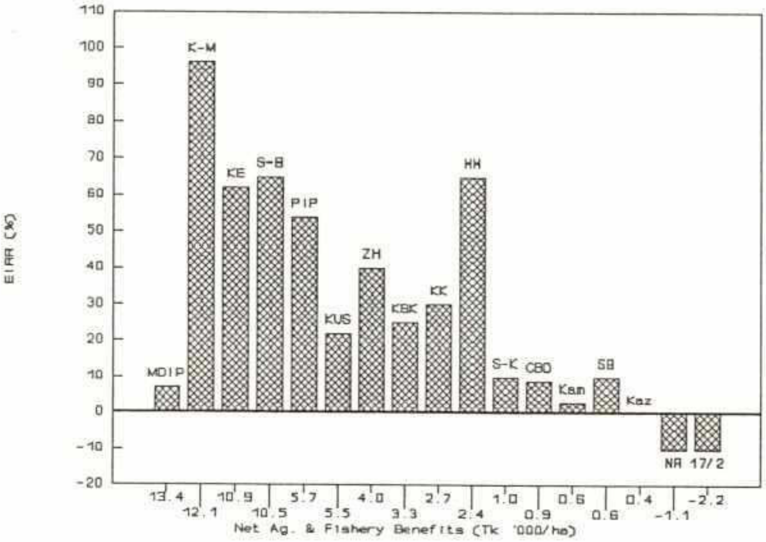


Figure 3.4 EIRR and Net Agricultural and Fishery Benefits
(negative EIRRs indicative only)



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		

3.12.4 Conclusion

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, communications impacts, and secondary economic impacts. These would tend to raise benefits by a (probably) small amount, but could not be estimated in the RRAs with any confidence. In the case of flood damage the PIEs suggest that damages are if anything higher in extreme floods inside projects (see Section 3.10).

The post-evaluations conducted could not take into account the impact on 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 resulting, for example, from public cuts, and which are also prone to delays in implementation.

The profile of a viable project is one which is small, is based on a simple concept, yields a benefit of at least Tk 2000 per hectare after allowing for fisheries disbenefits, and is implemented quickly. On the evidence of FAP 12's PIE data the transition from B Aman to Local T Aman (the minimum expected agricultural impact of FCD) should generate net economic benefits of the order of Tk. 7 - 10000 per hectare, so economic viability should not be hard to achieve with a well-conceived project, provided that it is small and simple enough to avoid implementation problems.

One large project, namely Kolabashukhali, came out quite well in terms of EIRR. Another large project, Kurigram South, with an EIRR of 22 per cent also appears viable. A sensitivity test, however, suggests that considerable caution needs to be exercised, especially for very large projects like Kurigram South. Thus a reduction of average estimated paddy yields by 5 per cent in the with project situation, along with an increase of 5 per cent in the without project situation, drives the NPV below zero. For projects such as these, notions of viability need to be revised. Either a high EIRR of, say, 25 to 30 per cent should be used as the cut off point for project selection, or (preferably) a detailed assessment of project risk should be undertaken.

3.13 FINDINGS COMPARED WITH PREVIOUS POST-EVALUATIONS

3.13.1 Previous Evaluations

Over sixty FCD/I projects have been the subject of evaluation studies over the past twenty years (see Table 2.1). These studies have been discussed in Chapter 2.

These evaluations represent a substantial information resource which has often been neglected. Fifteen of the projects have been evaluated by two or more separate agencies, but the subsequent evaluations have rarely shown any awareness of the existence of their predecessors, or compared their results.

The FAP 12 team has reviewed previous evaluations of three specific projects which the team covered and has compared them with the FAP 12 results in the relevant PIE and RRA studies (Chalan Beel D, Kolabashukhali, and Polder 17/2). In addition, the team has reviewed the reports on the many other evaluations.

The results of these have to be treated with caution, as many were based on very limited fieldwork, and did not have as thorough an approach or as broad a disciplinary cover as FAP 12. In the circumstances it is remarkable to see the extent to which the conclusions of studies over the twenty year period are consistent, and the extent to which independent studies of the same projects reach similar conclusions.

In the following sections the conclusions of previous studies are compared with FAP 12 conclusions. Emphasis is placed on areas where previous studies add to or differ from FAP 12. References are included to some of the more important studies that relate to the analysis but no attempt has been made to refer to all the studies that support any particular statement.

3.13.2 Planning, Design and Construction

In most evaluations the engineering comments are project specific and are not generalised. However there are recurrent observations related to project construction:

- implementation periods tend to substantially exceed expectations on large and complex projects, leading to long delays in project benefits and reduced rates of return (MPO, 1991):
- long implementation periods and erosion result in the retirement of embankments before project completion, increasing construction costs (Thompson, 1990);
- reduced embankment standards are adopted during the construction phase, either because of financial constraints or because of land acquisition problems, leading to increased risk of embankment failure;
- embankment compaction is frequently inadequate, due to the absence of mechanical compaction, and especially when construction is undertaken under Food for Work (FFW) auspices.

Where there have been independent engineering assessments (Kolabashukhali) there is substantial agreement between studies. However, there is little evidence of evaluations resulting in modifications to projects, one exception being the addition of small sluices to CIP to relieve local drainage congestion after the first evaluation (BUP, 1982).

3.13.3 Hydrological Impact

The diversity of FCD/I projects noted by FAP 12 is reflected in the full range of evaluation studies. Unfortunately many fail to clearly identify the nature of changes (timing, duration, depth, location) in the flooding, drainage and irrigation regimes. Some however have noted the importance of these factors and the great difficulty in generalising conclusions (Mosleh Uddin, 1984).

An exception is in CIP where a major transition in normal monsoon water levels (or 'F-levels') was found (Thompson, 1990): before the Project 94 per cent of the area was deeply flooded annually (F2 or F3), but afterwards 89 per cent was shallowly flooded (F0 and F1). Changes in cropping pattern were directly related to these changes in monsoon water conditions. The duration of flooding was also found to have declined in general, even though some areas of severe drainage congestion were found. The results are comparable to those found in the PIEs of technically effective projects such as MDIP and Kolabashukhali.

3.13.4 Operation and Maintenance

The weaknesses of O&M of FCD/I projects are a recurrent theme in virtually all evaluation studies. Many reach the conclusions that resources for maintenance in particular are inadequate, and that local participation in both Operation and Maintenance is essential.

More specific observations that recur include the absence or non-appointment of khalashis (BETS, 1988), the control and operation of project structures by local influential individuals (IBRD, 1990a), the need to train khalashis, the need for O&M manuals, or the inadequacy of existing manuals, and the frequent complete absence of resectioning and excavation of drainage facilities (BETS, 1988). It is of interest that in CIP part of irrigation operating costs were recovered by having a secondary lift system by LLP which farmers paid for (Thompson, 1990), and that there was some link between project management and farmers, and with agricultural support services; in MDIP this does not appear to have developed as water is available free from the canals.

Three further aspects of O&M have received particular attention.

The use of embankments for secondary purposes was often objected to in earlier studies, and some proposed that illegal settlers be evicted and bullock carts be banned from using embankments as roads (DU, 1986). More recently, however, evaluations have tended to treat multi-purpose use of embankments as a project benefit, and recommended that they be designed as roads and be planted with fruit bearing and timber trees (ESL, 1986).

It has been suggested that the lack of O&M, and of local participation in O&M, indicates that farmers do not perceive benefits from the FCD/I infrastructure (IBRD, 1990a). This may be true of a small number of projects without a detectable impact, but in general the results both of FAP 12 and of previous evaluations clearly reject this hypothesis.

It has also been suggested (IBRD, 1990a) that there is an implicit preference for frequent rehabilitation and reconstruction over periodic and routine maintenance. This may reflect the opportunity costs of foreign and domestic resources. Past observation supports this hypothesis, but the approach is hardly consistent with long term sustainability and cannot be recommended.

3.13.5 Agricultural Impact

A review of analyses of agricultural impact, and in particular a comparison of evaluations of the same projects, indicates that most studies are able to identify significant changes in cropping patterns and cropping intensities with some confidence. However, in Kolabashukhali ESL (1986b) failed to detect the considerable expansion of monsoon cropped area found in the FAP 12 evaluation. This is perhaps a result of the ESL methodology, which did not use a preliminary RRA and did not sample a representative range of villages. Input estimates are much less reliable (particularly from RRAs) with considerable differences found between the estimates in the evaluations of Polder 17/2, and in the Chandpur area (BUP, 1982 compared with Thompson, 1990 - the latter being less reliable).

a) Yields

The analyses of yield changes display extraordinary diversity, and at times inconsistencies and implausible conclusions. It is clear that few analysts were able to identify the possible impact on average harvested yields resulting from reduced crop damage, in many cases because this aspect of project impact was not clearly understood. (Statements that yields remained unchanged accompanied confirmations that the crops were less vulnerable to flood damage.)

Thompson (1990) found that under normal conditions the same crops and paddy types did not have significantly higher yields inside CIP compared with control areas, but that in a flood year (1987) they were much higher because then (in an effective project) water levels remained relatively low and stable compared to unprotected areas. However, FAP 12 has found higher normal yields for some monsoon paddy types in the PIE projects, notably for T Aman (Section 3.5.3). Calculation of average annual yields which took into account the risk of different flood conditions (measured by flood level, although other dimensions of flooding are clearly also critical) was found to be complex, and obtaining suitable information from surveys difficult (Thompson, 1990). The indication was that the relative reduction in Aman yield in flood prone areas near CIP was more for TL Aman than for B Aman. The former is more vulnerable to greater flood depths, and is relatively likely to be grown in areas with a high risk of depths greater than its tolerance range, because broadcasting is not possible after an HYV Boro crop.

Evidence was also found of control area (without project) yields which were higher than pre-project feasibility studies claimed, so reducing the potential benefit (Thompson, 1990), as was found for MDIP (FAP 12).

b) Cropping Patterns

The changes observed in cropping patterns are inevitably diverse but two dominant features stand out.

Where a project reduces the depth and unpredictability of monsoon flooding this can promote moves from B.Aman to T. Aman and HYV T. Aman, and from T.L. Aman to HYV T. Aman. This was well demonstrated by CIP where higher areas which before had grown TL Aman switched to HYV Aman, and lower land switched from B Aman to TL Aman if there was a drainage congestion risk or to HYV Aman where drainage was better (BUP, 1982; Thompson, 1990). The same impacts have been found in a number of the projects studied by FAP 12.

Where a project reduces the risk of early monsoon flooding this can substantially promote rabi cropping. Where this occurs, it is potentially the largest source of agricultural benefits from FCD/I projects. In the 1970s the rabi crops promoted were diverse (Mosleh Uddin, 1984). In the 1980s HYV Boro was by far the most important beneficiary (MPO, 1991). Many studies note the difficulty in separating the impact of simultaneous development of irrigation from FCD/I project impacts, and some probably exaggerate the benefits attributable to FCD/I. The extent to which benefits from rabi crops can be attributed to FCD interventions has elicited considerable controversy, with some commentators being unwilling to accept that studies so far have convincingly demonstrated a link between increases in dry season production and the presence of flood control embankments (IBRD, 1990a).

It now appears clear (see Section 3.5.2) that in some circumstances rabi cropping is benefited by FCD interventions, for example, where Boro crops are protected from early floods, and in coastal areas where flood protection results in reduced soil and water salinity levels. The two evaluations of Polder 17/2 reveal the need to carry out RRAs or studies at different stages in the project life, since HYV Boro only started to be grown between the earlier evaluation (Nabiul Islam, 1988) and the FAP 12 evaluation when salinity was less and ground water exploitation had started. However, each case must be examined carefully to avoid overstating this contribution.

Benefits to Aus cultivation have generally been few, since Boro has tended to replace this crop. Exceptions are CIP where a growth in Aus was reported during the transition period between FCD and FCDI (Thompson, 1986), and MDIP where some farmers obtain three HYV paddy crops a year (FAP 12).

In the great majority of cases FCD/I projects were shown to have only a marginal impact on cropping intensities - increases of 5 to 15 percentage points are the norm, even where project feasibility studies had forecast much larger increases. However, lack of increase, or even a decrease in intensity, is not inconsistent with a positive impact on output. One fairly widespread case is when a combination of project and small scale irrigation causes the replacement of a cropping sequence of rabi followed by broadcast Aus/Aman, by a sequence of Boro followed by T Aman. Counting the Aus/Aman as two crops, this would reduce intensity from 300 per cent to 200 per cent on the area affected.

3.13.6 Livestock Impact

This aspect of FCD/I impact is almost never referred to in previous evaluation studies.

3.13.7 Fisheries Impact

The FAP 12 conclusions are strongly supported by numerous previous studies, although quantification is rare. Where attempts have been made to quantify the impact a comparison with more recent analyses suggests that the earlier estimates were far too low (BETS, 1988a, FAO, 1989). Many studies have noted enormous declines in capture fisheries (MPO, 1991), and an unexploited potential for culture fisheries which could significantly mitigate this (IBRD, 1990). In CIP the loss of capture fisheries was considerable, but was also probably underestimated, but a major increase in culture fisheries was found in CIP (Thompson, 1990) which was partly due to flood protection. However, CIP has an unusually high density of ponds, and fish cultivation had also grown in unprotected areas nearby.

Several studies of coastal polders have replicated the FAP 12 observation that shrimp producers have been able to protect themselves from the potential negative impacts of flood protection (BUP, 1988, Mosleh Uddin, 1984).

3.13.8 Social Impacts

Most of the project evaluations have had a socio-economic orientation and a wide range of possible impacts have been examined. In some areas the FAP 12 conclusions are replicated almost invariably:

- FCD/I projects have a substantial positive employment impact, always through direct employment in construction and usually through agricultural intensification - for example CIP created 40 per cent more work in agricultural labour per cultivated ha. (Thompson, 1990); these impacts are offset to some extent by declines in capture fisheries activities;

- FCD/I projects almost invariably improve road communications and this is a significant source of secondary benefits (improving access to markets and social services);

- FCD/I projects usually have a negative impact on navigation. In the south this is often serious, and at times large numbers of boats have been manhandled daily over the embankments (Mosleh Uddin, 1984). Some observers have recommended installation of navigation locks in embankments as a mitigatory measure (DU, 1986). CIP is a rare example of a project with a navigation lock, although road transport is now much more important than boats within the Project (Thompson, 1986);

- land acquisition problems have been a frequent source of problems, delaying project implementation, leading to undesirable changes in design of embankments, and resulting in dissatisfaction over both the level and timing of compensation payments;

- social conflicts between affected groups have often been noted, particularly, in coastal polders, between farmers and those involved in shrimp culture (BETS, 1988; Nabiul Islam, 1988) and elsewhere between owners of high and low land (IBRD, 1990a).

In other areas investigations have generally failed to identify impacts - studies of landholding sizes, housing, asset formation, income distribution and particular impacts on women have generally been inconclusive.

The exception is in CIP where these issues have been investigated in greater depth than elsewhere. Thompson (1990) found that overall incomes were 25 per cent higher inside the project than in control areas, but that this benefit was unevenly distributed - marginal farmers and landless labourers had not gained while large landowners and households with salaries were relatively better off (a pattern confirmed in those PIE projects where benefits were detected by FAP 12). Landholding size differences between project and control areas were not related to the project, but it appeared that in control areas small decreases in landholding were widespread whereas larger landowners inside CIP had been able to maintain their holdings. A widening disparity between rich and poor was found to result in CIP from: labourers receiving the same real wages due to competition from non-project labourers and population growth, while larger landowners had preferential access to irrigation and did not share crop in land or hire in draft power. Also people with sufficient land had in some cases sold land when prices rose because of the project and diversified their income sources - for example moving into trade and obtaining employment abroad (which may also occur in Zilkar Haor area).

Although in CIP the growth in fish cultivation has enabled many fishermen to retain a livelihood (unlike some of the FAP 12 study projects) it was not possible to trace the fortunes of past fishermen. Fishermen inside the project were, however, found to be more dependent on rich landowners for whom they catch fish from cultivated ponds (Thompson, 1990).

Chowdhury et al (1989) undertook the only previous study which focused on the impacts of a FCDI Project (CIP) according to gender. They found that women's workloads had increased because of the increase in paddy production. Although mechanised husking had expanded, richer households employed considerably more poor women in post-harvest processing; results which agree with those found in the PIE projects.

Several reviews of impacts on land tenure and land prices have shown significant impacts:

- land prices within protected areas, and particularly the prices of low lying land, have often jumped sharply, compared with prices outside the project area. At times this has been accompanied by land speculation, so that the benefits did not accrue to the original landowners (Md Ali Akbar, 1980);

- sharecropping relationships have changed in protected areas, particularly in the south. Landlords have claimed larger shares of the crop or replaced sharecroppers with direct labour (Md Ali Akbar, 1980 and Mosleh Uddin, 1984).

These observations confirm that FCD/I projects offer clearly discernable benefits to the protected areas, but that they may often be "confiscated" by increases in economic rents accruing to non-farmers. For example, in Kolabashukhali the local 'elites' have appropriated the khas land which the project has made cultivable (an impact not detected by ESL, 1986b).

The social analyses have thus noted that there are frequently both benefitted and disbenefitted groups affected by FCD/I projects, and several have suggested that future projects should incorporate measures to compensate those expected to disbenefit (MPO, 1991).

3.13.9 Environmental Impact

The only environmental observations (distinct from those referred to above) that appear regularly in previous evaluations relate to silt deposition - frequent assertions that reduced depositions of alluvial silt are reducing soil fertility and occasional problems caused by sand accumulations following breaches and cuts in embankments. There are occasional references to changes in vegetation (particularly in the Coastal Polders where changes in salinity conditions significantly change the micro-environment) and in the numbers of rats (increasing and damaging embankments) and frogs (decreasing in the south, reducing incomes to frog catchers supplying the frog-leg processors).

There are occasional discussions of public health impact, which vary in their conclusions. Some evaluations stress the negative effects of the remaining ponded stagnant and polluted water while others have suggested flood control reduces the incidence of malaria and cholera (FAO, 1989). The evidence presented for both arguments is limited.

3.13.10 Off-Site Impacts

No awareness of potential off-site impacts of FCD projects was demonstrated before 1988. Since then several studies have commented on the impacts of projects in the Southern and North-west Regions on outsiders through changes in external flooding, drainage and navigation conditions (BETS, 1988a; FAO, 1989; MPO, 1991).

3.13.11 Non-Agricultural Flood Hazard Reduction

Although many of the evaluations record local views that FCD/I structures have increased their security, significant explorations of non-agricultural benefits from increased flood security are rare, a major exception being the study of Chandpur Irrigation Project (Thompson, 1990) which found relatively low damages to rural households in the 1987 floods outside the project (which were of moderate severity in that area) but did note damages inside the project due to drainage congestion and settlement of low land because of the perceived elimination of flood risk - a process also noted by FAP 12 in some projects.

The issue has also been discussed in the context of the Brahmaputra Right Embankment (BRE), where analysts have observed the importance of issues such as physical protection, psychological security and political imperatives related to FCD interventions (DU, 1986; FAO, 1989; IBRD, 1990a).

An aspect of project performance which has been ignored in almost all previous post-evaluations has been the risk of failure of embankments, although this was noted to be a serious problem in a number of the projects studied by FAP 12, and its implications for benefits and the economic analysis. Thompson (1990) estimated very approximately the implications of a 1-in-5 year risk of embankment failure for CIP (this frequency of failure having been found over a long period in the Gumti embankments within the same region) - the resultant agricultural and housing damages meant that the EIRR was halved to the range of 2-4 per cent by this risk.

3.13.12 Economic Evaluations

Economic analyses were not generally undertaken in the evaluations carried out before 1987 (except for the BUP (1982) study of CIP). Most subsequent evaluations have included calculation of an EIRR, but the methodologies used have varied and the assumptions used have sometimes been based on dubious grounds (expected but unobserved benefits for example.)

Nevertheless four broad features are noted:

- economic analyses of submersible embankment projects show very high rates of return, compared to analyses of other projects using similar methodologies (BUP,1988; MPO, 1991);

- large and complex projects usually show marginal or low rates of return (BUP, 1982; Thompson, 1990; IBRD,1990; IBRD,1990a; MPO,1991);

- in the major FCDI projects evaluated (CIP and MDIP) agricultural benefits have been substantial (both due to irrigation and flood control), but there have been major problems due to erosion and project planning, and long delays during implementation, resulting in poor economic performances (BUP, 1982; Thompson, 1990).

- the benefits from increases in output of Boro HYV often contribute a high proportion of total economic benefits, on projects with relatively high EIRRs.

4 RECOMMENDATIONS

4.1 INTRODUCTION

In the following sections the recommendations arising from the FAP 12 studies are presented. The recommendations arise both from conclusions in the present report and from the more detailed PIE and RRA studies, as well as from the detailed investigations into O&M that have been carried out under the closely linked FAP 13 study.

In order to avoid excessive repetition, and to facilitate reference to the detailed discussions and observations leading to these recommendations, reference is made in every case to at least one source of the recommendation. In these references the following abbreviations are used:

MR FAP 12 Methodology Report

FAP 12 PIE Report on:

CB Chalan Beel Polder D
KS Kurigram South
MDIP Meghna Dhonagoda Irrigation Project
ZH Zilkar Haor
KBK Kolabashukhali Project

FAP RRA Report on:

PIP Protappur Irrigation Project
NR Nagor River Project
SBB Sonamukhi Banmander Beel Drainage Project
SB Improvement of Sakunia Beel
SK Silimpur-Karatia Bridge cum Regulators
KK Khatakhali Khal
HH Halir Haor
KME Kahua Muhuri Embankment
KE Konapara Embankment
17/2 Polder 17/2
KAM BRE Kamarjani Reach
KAZ BRE Kazipur Reach

DFR FAP 12 Draft Final Report

O&M FAP 13 Draft Final Report

References to a specific page are noted as (HH2-3). References to a section or sub-section are noted as (DFR S3.12). No attempt has been made to record every reference to some of the recommendations. Recommendations that are specific to a particular project are not reproduced here - they will be found in the PIE or RRA report on that project.

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4.2 PLANNING AND DESIGN OF FCD/I PROJECTS

4.2.1 Project Planning and Design

a) The Planning Process

In project selection priority should be given to small projects which represent an evolution of local practice and are modest in their engineering interventions and costs (PIP10-7).

Project planning must take into account not only within project (on-site) impacts but also external (off-site) impacts. The latter usually occur in adjacent rivers and the land beyond them, and in downstream rivers and areas. Special attention should be given to impacts that are cumulative in time and/or spatial dimensions. In particular, wherever there is reason to believe that a polder may significantly affect water levels outside its own area, its planning should be part of regional basin studies (NR10-14)(CB).

Before implementation of Coastal Polders morphological studies of tidal rivers are necessary to allow designs to minimise siltation problems (17/2 2-6).

The planning process must involve wider consultation than has been the case in the past, including a wider range of Government Departments (including agriculture, fisheries, forestry, livestock and roads and highways), local authorities, NGOs and the expected beneficiaries. This process should include public meetings at which the proposed interventions, and their implications, are clearly explained and discussed (HH6-3)(SB4-6)(SK3-3). FCD/I projects located near the international border require collaboration with India to ensure realistic project design (SBB).

It should be emphasised that the consultation process should not only permit BWDB and FAP planners to accommodate the responses of others. It should also facilitate the introduction of complementary activities by other agencies - in agricultural extension and promotion of culture fisheries for example. More integrated planning of roads and embankments is particularly essential, as several cases were found when developments took place at cross purposes (17/2iv).

The planning stage of all FCD/I projects should include a benchmark survey of the hydrological, soils, land use, agricultural, fishery, livestock, ecological and socio-economic conditions in the area. The survey should attempt to identify trends of change as well as the existing situation (KBK). Benchmark surveys should include off-site areas where impacts are anticipated, and for major projects should also cover a "control" area if one can be identified.

Planners must, in particular, be clear about the characteristics of FCD/I pre-project hydrology (for example the timing, depth, location, speed, probability, predictability and sediment load of floods), their consequent impact on agriculture, and how these characteristics are expected to change following the FCD/I intervention. Only then can expected impacts be confidently predicted (DFR S3.12.3).

b) Embankments and Structures

Embankments should be designed for multi-purpose uses, which may include roads, housing, emergency shelter for flood victims (human and livestock), tree production (for fuel, fodder, fruit and above all protection), vegetable production, forage crop production and transshipment of goods, in varying circumstances (SB2-6,5-5)(KE5-3)(KAZ2-5)(KAM5-8).

Wooden fall-boards are generally inappropriate as the main control means in regulators, particularly in submersible embankment projects (HH2-5, O&M3-7, DFR S3.3.2).

Structures on submersible embankments should be designed for operation with sizeable head differences (HH2-5).

Where regulator gates are intended to retain water for irrigation purposes or to stop intrusion of saline water they need to be equipped with watertight seals (PIP2-6).

c) Drainage Planning

The planning of drainage networks and drainage regulators for FCD/I projects requires more intensive investigations of existing drainage conditions than have been carried out in the past (SB2-6)(KBK).

Drainage and irrigation channels and borrow pits need to be designed with enough inexpensive crossing points to avoid disruption of existing communications (SB11.5).

The possibility of using borrow-pits, excavated beels, khals and drainage channels as water storage units or for fisheries should be considered at the planning and design stages in consultation with DAE and DOF (SB4-6).

Completed projects which experience frequent public cuts, usually as a response to drainage congestion, should be reassessed and if necessary the original planning and design objectives should be modified (CB, NR). Compartmentalisation may the answer to these problems at some locations.

d) Planning for Emergencies

When planning submersible embankment projects, appropriate non-structural measures including safe places for housing, secure in extreme floods, should be provided for (HHiv).

Emergency planning for over-design events (particularly for cyclones in coastal areas) should be incorporated into FCD/I plans (17/2 7-3).

Means need to be developed of warning people who settle in lower places than in the pre-project period, that their sense of security is not fully justified, and that their property remains at risk during high floods.

4.2.2 Construction

The quality of embankment compaction must be monitored carefully by BWDB, particularly when FFW assisted work is undertaken (KE3-6).

Applied research on improved compaction methods is needed. In major embankments, mechanical compaction may be necessary, both during original construction and if they are reconstructed as retired embankments (KAZ3-3). Better monitoring of soil moisture during compaction is required for all methods.

Systematic methods of record keeping, and storage of project documents, including feasibility and design studies and as-built drawings, need to be introduced at BWDB field offices (NR11-6).

4.2.3 Agricultural Planning

When the irrigation component of a FCDI project is aimed at promoting rabi season development, the relative advantages of surface and groundwater irrigation must be very carefully weighed. Long-run O&M costs for surface irrigation may be lower than for groundwater, but groundwater irrigation is more flexible, managerially less complex and offers much better practical scope for cost-recovery, and is therefore more likely to be sustainable (PIP4-9).

4.2.4 Livestock Planning

As FCD/I projects have been shown to lead, in some circumstances, to declines in cattle populations, the implications of this need to be considered in FCD/I planning - for draught power requirements, nutrition and net increases in agricultural incomes (PIP5-5).

The use of urea treatment of straw and of urea-molasses blocks to promote better utilisation of increased straw output for cattle nutrition should be promoted widely (SB5-6).

4.2.5 Fisheries

Where an FCD/I project is expected to have a negative impact on capture fisheries mitigatory measures to promote culture fisheries schemes both for the benefit of former capture fishermen as well as for pond owners should be included in the project (SB6-4).

Where it is feasible sluices and drainage outlets should be designed to facilitate fish passage after pilot scale trials to verify their effectiveness (KE6-3)(O&M S6.3.4).

Those planning coastal polders where shrimp farming is likely to be involved or affected should use the experience of the World Bank shrimp farming project which shows that paddy farming and shrimp culture can co-exist (17/2 6-5)

Where project designs include retention basins and khals used for water storage (for irrigation for example) these should be sized and operated as far as possible to provide a permanent stock of fish (KBK).

4.2.6 Gender Aspects

Women's position and role in the society are determined mainly by tradition and custom. An improved economic situation may not necessarily improve their lot. Hence for any improvement of their situation, one needs activities aimed specifically towards such goals.

Means of including job opportunities for women (particularly the widowed and divorced) should be considered during project planning.

4.2.7 Social Aspects

Action is necessary to ensure that khas lands which a project makes cultivable are leased to the landless. The involvement of NGOs in the process is probably essential. (HH10-2)(KBK)

Where any social groups are expected to disbenefit as a result of FCD/I interventions specific mitigatory measures should be included and costed in the project design (SB11-5)(17/2 6-4)(DFR S3.12.8).

Where people have to be resettled because their land is acquired for embankments they could be involved in embankment construction, provided with house lots on the embankment, given responsibility for O&M of embankment reaches and allowed to exploit social forestry opportunities on the C/S (KAM2-9).

Means of including job opportunities for women (particularly the widowed and divorced) should be considered during project planning (PIP7-5)(NR8-2).

NGOs should be actively involved in these, and in other aspects of O&M activities, such as social forestry (KE9-4).

4.2.8 Ecology

Certain large projects may include sites of special ecological interest. In these cases consideration should be given to the possibility and cost of protecting these within the project.

External (off-site) ecological impacts may sometimes be important and should be explicitly anticipated at the planning stage.

4.2.9 Economic Analysis

All benefits and disbenefits must be costed wherever possible, and should in all cases be quantified.

Better documentation of the assumptions used in feasibility studies, completion reports and benefit-cost analyses is required, and copies of all planning, design and appraisal documents should be preserved in a systematic manner at project offices and BWDB headquarters.

Where benefits arise from increases in rabi crop production, and in particular from increased output of HYV Boro, these must be particularly critically verified (DFR S3.12).

Benefits from protecting against periodic flood damages, as opposed to long-term impacts on agriculture, fisheries, livestock, etc., need to be included in appraisals.

The delays likely in project implementation should be assessed realistically in project analyses, and in large and complex projects the sensitivity of ten-year implementation periods should be tested (17/2iv)(DFR S3.12.2)

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Economic analyses must include sensitivity analyses to examine the impact of plausible changes in implementation period, costs, fisheries losses and, in particular, differences from the basic yield assumptions of the main crops (KAZ, KAM).

4.3 OPERATION AND MAINTENANCE

4.3.1 Source of recommendations

This section is based on the more detailed recommendations made in the Draft Final Report of FAP 13 - the O&M study - which has been carried out in close collaboration with FAP 12. The recommendations arise both from the 17 case studies (RRAs and PIEs) and from a review of O&M initiatives and experience in FCD/I projects in Bangladesh and elsewhere. In many cases the recommendations point to the need for more detailed development of appropriate alternatives for improving O&M and these will need to be tested in a range of projects since different approaches are likely to be suited to different circumstances.

In a few cases the recommendations which emerge are similar to those concerning planning, since O&M problems were found to arise from planning practice as well as during the operating phase.

The general objectives of the recommendations are to increase public participation in system management as a means to increasing efficiency in O&M and to reduce resource demands on sources outside the benefited area and thereby create a self-sustaining system. The key aspect is to encourage and facilitate the use of resources created by FCD/I projects.

4.3.2 Planning

There are opportunities for interagency collaboration in project planning and management to achieve economies of scale in multi-objective projects. For example, there is scope for cooperation with DOF to mitigate fisheries impacts and make use of project waterbodies as productive fisheries, and with RHD and Upazilas for construction of combined embankments and roads and for implementation of joint maintenance agreements for such structures.

Experiments are needed in designing fish passes and then in finding operating patterns which achieve both agricultural and fisheries objectives.

Development work is needed in restocking beels and water bodies within projects, and in developing appropriate means of managing them; this could be as licensed common property resources or as leased 'privatised' resources for example.

If embankment use is to be a means of achieving improved maintenance and/or targeting benefits to disadvantaged groups, then embankments may need redesigning to permit use for housing and trees without affecting their primary objective of flood protection.

If linked compartments are planned, this should be done so as to minimise the need for coordinated operation and maximise the opportunities for local decision making.

Public participation is essential in project planning: if local people are to have real responsibilities for managing projects, the projects must be theirs from the beginning.

4.3.3 Public participation

The main scope for public participation is in surface water management (drainage in FCD projects), and in management and use of other aspects of the project infrastructure, especially embankments.

The responsibilities and duties of farmers, system management and other agencies need to be clearly defined, with each liable to provide the services it makes a commitment to. Some responsibilities in O&M can be devolved, others require coordination and monitoring to ensure that the whole project functions.

There should be clear lines of communication between end users and officials with system responsibilities.

Building up local participation in projects will require resources and time and some form of social organisers to build up the local institutions/groups.

There is a greater need for local control of resources and an ability to generate resources - by the Upazila, BWDB or whichever agencies are responsible for the systems - to ensure that locally generated resources are used in those systems and to increase local accountability.

4.3.4 Transition

A formal transition phase between the implementing agency or division and managing agency or division would clarify the distinction between implementation and O&M.

Any defects or problems in the project should be identified during the initial period and rectified before handing over a fully functioning system.

Training of system staff and group formation and extension work with user groups would establish the system in this phase.

As-built drawings of the project structures should be handed over to the system management.

Simple O&M guidelines and basic training should be provided to operators - whether system employees or user groups.

System level operating rules should be established based on actual operation in the transition phase.

Appropriate practical training and an advisory service is needed for each level of the managing agency and for the user groups, covering not just technical O&M but also for the different uses envisaged; for example house construction on embankments, tree cultivation, organising routine maintenance, and the rights of user groups.

Emergency plans must be established to cope with embankment failures or erosion and be regularly updated so that beneficiaries are aware of the continued risk and so that potential losses can be minimised.

4.3.5 Maintenance

For embankments, routine maintenance is preferred to the present practice of deferred or periodic maintenance. Alternatives are to employ earthwork teams (this work could be targeted at poor women as in other rural maintenance programmes), or to link maintenance requirements to leasing of embankments for other uses (houses, trees etc.).

For periodic maintenance the approach of directing employment to target groups and avoiding contractors as middle men should be tested by creating labour contracting societies.

Greater discretionary funds are needed for emergency maintenance/repairs so that these can be carried out immediately, thus preventing further damage and ultimately higher repair costs.

Regular monitoring of the state of repair of structures is needed along with prioritisation of work so that the most critical elements are kept in good repair and resources are used efficiently. Embankments must be adequately monitored so that danger areas can be upgraded before it is too late, to avoid excessive damage and probable loss of life (MDIP).

4.3.6 Resource Mobilisation and Use

The alternatives in resource mobilisation are: payment of fees for services given; self-contribution of resources (e.g. labour) by operators/beneficiaries; leasing out infrastructure use to raise revenue to fund O&M; and making proper maintenance a condition of rights to use the infrastructure. All should be experimented with.

Any programme for using embankments for trees and other crops should ensure that this does not damage the embankment and that proper maintenance is carried out. This would reduce the area of unused land, and direct some benefits to target disadvantaged groups. Experiments to develop this approach and find the best technical and institutional arrangements are needed.

Use of beels, khals and borrow pits for fisheries likewise needs experimental development to see if self sustaining natural but managed capture fisheries, or stocked fisheries and more intensive cultivation, can be established, and to find effective management and institutional arrangements such as fishermen's cooperatives.

Housing on embankments could be permitted in a planned way by designing the embankment for this purpose and then settling those displaced by erosion on condition that they maintain their reach of embankment. Again, development work and trials with alternative embankment designs will be needed.

Means of increasing use of FCD/I project infrastructure and making this conditional on effective maintenance are attractive, as costs could be cut and disbenefits reduced or new benefits created, thus improving the economic performance of projects.

4.4 AREAS FOR FURTHER INVESTIGATION

4.4.1 Engineering Design

The application of compartmentalisation approaches to haor areas appears to offer promising benefits, and deserves detailed investigation (HH2-5)(HH2-6)(HH4-6). This may be appropriate to FAP 6 and/or FAP 20

The use of fixed weirs or spillways for water regulation should be studied, as an alternative to regulators with moveable gates, as fixed structures are cheaper, more durable and less susceptible to incorrect operation (PIP2-6)

It is alleged that rising river beds are threatening the submersible embankments at their current heights (HH11-4). This requires study by FAP 6.

There is frequent speculation about the impact of Flood Control on groundwater resources but little data on which to base this. A detailed monitoring programme would be required to provide a firm basis for evaluating these impacts. This might be carried out under the auspices of the planned National Minor Irrigation Development Project (NMIDP) (SK11-10).

The scope for and benefits to irrigation in saline-exclusion polders should be investigated (KBK). This may be followed up by FAP4.

4.4.2 Hydrology

Important changes in river morphology in adjacent and/or downstream rivers are often alleged or inferred to arise from FCD/I interventions. These specifically include accelerated bank erosion and depth reduction due to siltation. A detailed monitoring study of relevant rivers is required. This might be undertaken at the River Training Institute of BWDB.

4.4.3 Agriculture

Applied research is required into early maturing paddy varieties appropriate to Haor areas (HH4-6)

Applied research is required into improved paddy drying and processing methods, especially for application in Haor areas (HH4-6)

4.4.4 Fisheries

Applied research is needed into the effect on fish stocks of drying out beels using LLPs (HHiv). This might be undertaken by FAP 17.

New approaches to fisheries leasing systems need to be investigated (HH10-2). This again might be undertaken by FAP 17.

4.4.5 Gender Aspects

Research is needed into the differential mechanism for coping with extreme stresses during flood by men and women. Another topic of importance for future studies is an assessment of relative roles of tradition and other factors (economic, demographic) in determining intra-household food intake at various levels of economic well-being. Both of these will facilitate framing of future policy options to improve the position of women.

4.4.6 Social Aspects

Legal issues related to land revenues need to be resolved, and procedures for compensation payments need to be accelerated (KE9-4)(KAZ9-5). FAP 15 is covering these issues.

It has been suggested that land speculation can lead to unintended and inequitable distributions of FCD/I benefits (DFR S3.12.8). Further study may be needed (FAP 16 or FAP 26?) to verify this hypothesis, and, if necessary, to identify possible ways of avoiding this.

4.4.7 Ecology

Research should be undertaken into appropriate flood tolerant trees for planting on submersible embankments (HH P11-5). This might be undertaken under FAP 13, Phase II

Given the continuing widespread belief that FCD/I projects lead via reduced flooding and silt deposition to declining soil fertility and deteriorating soil physical characteristics, further investigations are essential (SB10-3). This may be undertaken by FAP 16.

Project impacts on public health are at present indeterminate. More detailed investigations are justified (SB10-3)(DFR S3.12.9)

Detailed monitoring is required of water quality in representative on-site and off-site wetlands, rivers and groundwater to assess project impacts and trends. This should investigate changes in or due to sewage, agrochemicals, agro-industrial effluents and sediment loads.

There is a general need for baseline information and monitoring of changes in wetland ecology in FCD projects. This could be addressed by FAP 16 and/or a long-term environmental monitoring unit.

4.4.8 Economics

There is a serious lack of reliable data on flood damages, particularly to property and infrastructure, but also to agriculture, from which to estimate flood protection benefits. These impacts could not be properly assessed by FAP 12. Research is need to provide a comprehensive data set and methodology which could be applied consistently across FCD/I project appraisals in Bangladesh.

4.4.9 Evaluation Methodologies

It will be increasingly difficult in future to apply the control area methodology for evaluation of FCD projects, and guidelines for a longitudinal methodology, including specification of the necessary baseline surveys, need to be developed. This should be done as part of a major strengthening of BWDB's monitoring and evaluation institutions to enable them to specify and supervise studies over a long time-span.

4.5 METHODOLOGIES FOR IMPACT EVALUATION

4.5.1 RRA as a Tool for Post-Evaluation

a) Composition of RRA Teams

Multi-disciplinary RRA for project evaluation is not a suitable technique for transfer to inexperienced professional staff, and still less to enumerators without professional training. Even with well-qualified and highly experienced staff it is necessary to be rigorous in selecting only those who can interact productively in a multi-disciplinary team. Strong leadership by a person of very broad experience is desirable, and safeguards against professional bias should always be implemented.

b) Level of Quantification

It is possible in RRA to quantify relative crop areas and cropping intensities by land level from data collected in group interviews, using a simple matrix approach, and this should be adopted as standard practice for RRAs in Bangladesh aimed at agricultural impacts. It is straightforward to obtain specimen crop budgets for the main crops through group interview, though the budgets may tend to represent 'best local practice' rather than the mean. Where these data can be matched to reliable secondary sources on absolute areas, quantified estimates of agricultural benefit can be made and used as a basis for economic reappraisal.

c) Avoidance of Bias

Some types of bias, notably biases resulting from the season of observation, are difficult to avoid entirely without sacrificing the speed of execution which is a main virtue of RRA. Avoidance of socio-economic bias requires conscious effort and provision of suitable staff (especially for interviews with women). It also requires careful and diplomatic preparation of group interviews, and this is not compatible with a highly compressed time scale for fieldwork. The use of a control area, to avoid incorrect attribution of changes over time to project impacts, should be incorporated where possible, though again this will increase time requirements.

Cross-checking of responses is essential, and should involve group interviews in different areas covering similar questions, professionals of different disciplines visiting the same areas, discussions with Upazila officials, and comparison of official data with primary RRA data.

d) Time for Execution

Even for small projects (under 5000 ha.) a minimum of one week's fieldwork is required, and this would rise towards two weeks if a control area is used. Fieldwork should be preceded by a week of preparatory study of documentary sources. Time requirement for writing up depends heavily on the fluency of team members in the working language, but would normally be at least two weeks for production of a draft report. Further editing, preferably after independent review by a senior professional not involved in the RRA, will normally be required before report finalisation.

4.5.2 Project Impact Evaluation

a) Approach to Measuring Project Impacts

Unless a well-executed baseline survey has been conducted pre-project, measurement of project impact will normally require a control area approach for assessment of without-project trends. Selection of undisturbed control areas for FCD/I projects is increasingly difficult, however, and the approach may cease to be viable in the foreseeable future. A strategy based on comparison over time may then be necessary, which would in turn require good baseline surveys. To provide these in a timely manner and to a good and consistent standard would require a major strengthening of project evaluation institutions in Bangladesh.

b) Targeting Formal Surveys

A preparatory RRA survey of an area designated for formal survey is highly desirable in order to detect key issues and to prepare schemes of stratification where these are appropriate. The team for a preparatory RRA must include the personnel who will design the formal survey, and should if at all possible include the personnel who will analyse it, where these are not the same as the designers.

c) Sampling Approaches

Probability sampling should normally be employed in order to obtain the advantages of known margins of sampling error in survey estimates, at least for the samples intended to provide the most important (normally agricultural) variables for project impact.

Logistical factors will normally dictate a two-stage approach to probability sampling. A suitable first-stage sample unit is the mouza or revenue village, and mouzas can be selected either with probability proportional to size (PPS) or by simple random sampling (SRS). The second-stage sample unit will normally be the household, selected by SRS. Sample frames can be based on local (Union Parishad) lists of taxpayers, updated by group interview.

Whether PPS/SRS or SRS/SRS sampling is used, care should be taken to obtain the relevant variance algorithms for the selected design, since those supplied as standard in proprietary statistical packages are not appropriate.

Sample size required for a stated level of accuracy will vary appreciably between different parts of Bangladesh, but is unlikely to be less than 60 per domain of study even for modest levels of confidence and precision, and may be considerably greater. Samples should be dispersed as widely as possible, preferably no more than 5 respondents being interviewed in any single first-stage unit in order to minimise intra-cluster correlation effects.

c) Timescale for Formal Survey Programmes

Timescales will vary widely depending on the level of detail specified in the survey. FAP 12 experience with a complex questionnaire indicates a period of not less than one month for questionnaire development, pretest and enumerator training. Sustainable field interview rates, again with a complex questionnaire, should be not less than 1.5 interviews/enumerator/day. Time for assembling sample frames using local tax lists is typically about half a day per first-stage sample unit.

Time requirements for analysis of formal surveys are also highly dependent on resources and complexity, but at least 2 weeks per 300 questionnaires should be allowed for data entry and checking of a complex questionnaire and at least a further month for tabulation, analysis and draft reporting (depending on computer resources more time may be needed).

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APPENDIX A

FAP 12 TERMS OF REFERENCE

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APPENDIX A

ACTION PLAN FOR FLOOD CONTROL
TERMS OF REFERENCE FOR FCD/I AGRICULTURAL STUDY

1. BACKGROUND

1.1 In 1987 & 1988 Bangladesh experienced two of the most severe floods on record. These floods created awareness both at home and abroad and called for finding a solution to such environmental disasters. Soon after the floods, various studies were conducted by different agencies, countries and Government of Bangladesh.

1.2 The World Bank drew on the findings and framed a flood Action Plan (FAP) with 26 components as the initial stage in the development of a long term comprehensive system of flood control and drainage works. Out of these 26 components, 15 are supporting activities. FCD/I Agricultural Study is one of these supporting activities and would involve a comprehensive evaluation of agricultural, economic, environmental and social impacts of existing projects.

1.3 Despite considerable experience gained in the planning, implementation and operation of FCD[1] and FCDI[2] projects over the past 25 years, there have been a few indepth evaluations of project performance. A review of FCD and FCDI projects is needed in order to learn from previous experience and to provide an input to the planning of the proposed system of embankments and compartments under the Action Plan.

1.4 The study will be financed by the British and Japanese Governments.

2. REGION

The study will take place in all the regions identified for planning purposes in the Action Plan.

3. SCOPE OF WORKS

3.1 Over the past 25 years, considerable experience has been gained in the planning, implementation and operation of FCD and FCDI projects. Such projects account for about half of the investment in the water sector (most of the remainder being in minor irrigation) and cover over 10 percent of the country. They are designed to increase both agricultural production and the intensity of cultivation through improvements in the water regime (i.e., changes in the depth, timing and duration of flooding). Despite the importance of the sector, there have been very few evaluations of completed projects and those that have been undertaken have not been very useful due to methodological and other shortcomings.

The proposed FCD/I Agricultural Study would be to undertake a comprehensive review of FCD and FCDI projects. The overall aim of the study would be to assess the effectiveness of investment in this sector; to learn from previous experience in the planning, design, implementation, operation and maintenance of projects; and to

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[1]Flood Control and Drainage

[2]Flood Control, Drainage and Irrigation

provide an input to the planning of the proposed system of embankments and compartments under the Action Plan.

The objectives of the study would be to :

- assess the agricultural, economic, social and environmental impacts of FCD and FCDI projects and the extent to which technical and other project objectives have been achieved;

- identify constraints to effective project management and to recommend ways in which project design, operation and maintenance can be improved to increase the overall production;

- develop guidelines and criteria to be used in the planning, design, implementation, operation and maintenance and evaluation of projects under the Action Plan.

4. TERMS OF REFERENCE

4.1 The Study would be undertaken in three partly overlapping stages :

4.1.1 Stage 1 : Methodology, Project Selection, Training

Development of the methodology to be used in the evaluation of projects, selection of projects for evaluation, recruitment of specialists and training of field assistants.

4.1.2 Stage 2 : Rapid Project Evaluations

'Rapid Rural Appraisal' of 12 completed projects (including major FCD/I projects and medium and small scale FCD/I projects) by inter-disciplinary teams of professionals to undertake the overall assessment of performance, problems and potential of each project.

4.1.3 Stage 3 : Full Project Impact Evaluation

Detailed evaluations of the agricultural, socio-economic and environmental impacts of a further 6 completed projects using quantitative and qualitative data collected in field surveys in project areas (with present projects') and neighbouring unprotected areas (without projects').

4.2 The terms of reference for the three stages of the study are as follows :

4.2.1 Stage 1 : Methodology, Project Selection and Training

In stage 1, the consultant would :

(a) develop a methodology for the rapid evaluation of FCD/I projects. In doing so, the Consultant would take account of work undertaken by MPO and other organizations;

(b) develop a methodology for full project evaluations of FCD/I projects. In doing so, the Consultant would, inter-alia, review previous evaluations undertaken by BWDB, MPO, IFCDR (Institute of Flood Control and Drainage Research), BUET, BAU, BIDS, donors and independent researchers, relevant research institutions and earlier critiques of such studies;

(c) organize a workshop of specialists, including members of the Panel of Experts and those undertaking other Action Plan activities to discuss the methodologies;

(d) select the projects to be evaluated through Rapid Project Evaluations and full Project Impact Evaluations. The projects selected will be representative of the types of FCD/I projects undertaken in Bangladesh, including projects in the North-west and North-Central regions where the first regional studies will be carried out; and

(e) train field assistants in the techniques to be used in both Rapid Project Evaluations and Project Impact Evaluations.

4.2.2 Stage 2 : Rapid Project Evaluations

In stage 2 the Consultant would undertake Rapid Project Evaluations (RPE) of the 12 selected projects. This would be undertaken by an interdisciplinary team of professionals (comprising an agriculturist, irrigation and drainage engineer, fisheries specialist, environmental specialist, sociologist and economist plus a small team of field assistants).

In undertaking the Rapid Project Evaluations, an attempt would be made to make an overall, qualitative assessment of project impacts together with more accurate estimates of key variables. Inter-alia, the teams would attempt to:

- asses the impact of the project on cropping patterns by land type, yields and crop production ; on the production of culture and capture fisheries ; on rural industries and services, including transport; on other aspects of the environment, on on-farm and off-farm employment of men and women and on neighbouring areas;

- assess the impact of the project on income distribution and employment and to try to analyse the attitudes of different interest groups in the area to the project;

- assess the suitability and effectiveness of the design and construction of the engineering works associated with the project, including maintenance requirements, and to estimate the cost of the works carried out for use in the economic assessment;

- compare the impacts of the project with planned impacts and the actual costs of implementing, operating and maintaining the project to planned estimates;

- assess any problems in the effective operation and maintenance of the project (including details of social and any other conflicts), to identify ways in which

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such problem could have been overcome at planning and design stages and to propose any remedial efforts (e.g, new work or operating procedures) that could increase project effectiveness. This would be done in close co-operation with staff from the O&M study (Action Plan Item No. 13);

- assess the extent of consultation between BWDB and the beneficiaries, elected representatives, and officials of other government agencies in the planning, design, implementation, operation and maintenance of the project and, if considered necessary, to suggest ways in which consultation could be enhanced in future;

- assess the extent to which project activities and assets have been targeted to benefit the rural poor (e.g., leases on borrow - pit canals and embankments to groups of poor men and woman ; use of labour contracting societies in undertaking works) and to suggest ways in which such targeting be undertaken in future;

- assess the impact of the project on livestock (draft power, meat and milk production, fodder), on the availability of fuel and organic matter , and on short and likely long term soil fertility;

- assess the impact of the project on human diet and nutrition; and

- assess the overall economic impact of the project including an approximate estimate of the IRR of the project.

4.2.3 Stage 3 Full Project Impact Evaluations

In stage 3 the Consultant would undertake full Project Impact Evaluations (PIE) of six projects in which accurate and quantified estimates of project impacts would be made. The project impact evaluations would take about 8 months. The project impact evaluations would address similar questions to those in the rapid project evaluations but would differ in that the aims would be to:

- make quantitative estimates of net project benefits through household sample surveys of farmers, agricultural labourers, those engaged in culture and capture fisheries, rural industry and service owners and workers, and others in the project area;

- compare the situation in the project area both with the conditions before the project (i.e. before and after comparison) and to that in similar areas outside (i.e.,'with' and 'without' project comparison) and to assess any impacts of the project on neighbouring areas;

- assess in more detail the various impacts of the project (e.g., on cropping patterns, fisheries) and the response of households in the area in order to identify ways in which positive project impacts can be maximized and negative impacts minimized;

- undertake land resources appraisals (including where necessary soil surveys and assessment of irrigation potential) in order to assess the physical constraints to and potential for increased agricultural production and crop diversification;

- estimate the social and environmental impacts of the project on the savings and investment behaviour of farmers , fishermen, rural industries and service owners and others through a comparative study of enterprises and households inside the project.

4.2.4 In both Rapid Project Evaluations & the Project Impact Evaluations great care would be taken to distinguish project and non-project impacts (i.e., change in project areas such as ground water and surface water development result from the project as opposed to those that would have occurred anyway). In each stage the consultant would:

- organize workshops of specialists, including members of the panel of experts and those undertaking other Action Plan activities, to discuss the results of the project impact evaluation and to draw lessons to use in the planning implementation, operation and maintenance projects under the Action Plan;

- produce reports summarizing the main findings of the project and summarizing the findings of the project impact evaluations.

4.2.5 Relationship to Other Studies

The team undertaking the study would work in close co-operation with the Flood Plan Co-ordination Organization, with the members of the panel of experts and with the teams carrying out the regional studies (Action Plan Items 2 to 6), the other socio-economic and environmental studies (item No. 13 to 17), the Compartmentalization Pilot Project (Item No. 20), the Flood Proofing Pilot Project (Item No. 23) and the special study on the methodologies for the economic analysis of FCD/I projects. Care would be taken to ensure that duplication of the different studies is minimized.

5. REPORTS

The following reports would be produced :

Inception Report	: Month - 1
Draft Report on stage-1	: Month - 2
Final Report on stage-1 including workshop output	: Month - 3
Draft Report on stage-2	: Month - 7
Final Report on stage-2 including workshop output	: Month - 8

Initial Report on stage-3 for discussion in workshop : Month -7

Draft Report on stage - 3 : Month -11

Final Report on stage - 3 including workshop output : Month -12

6. STUDY DURATION AND SCHEDULE

The study would last for 12 months and would be divided into the following stages :

- Stage 1 :	Mobilization, Methodology, Project Selection, Training	Months 1 - 3
- Stage 2 :	Rapid Project Evaluations	Months 4 - 8
- Stage 3 :	Full Project Impact Evaluations	Months 4 -11
- Stage 4 :	Final Report Preparation/ Workshop.	Month -12

An activity schedule is shown in Figure 1.

7. STAFFING AND OTHER INPUT

The study would be undertaken by the British-Japanese Consultancy Team in close collaboration with national research institutes.

The study would require 281 person months of consultancy inputs divided into 45 person months of expatriate consultants and 236 person months of local consultants. The figures given below are indicative.

7.1 The British/Japanese Team would comprise:

	Person Months
- Team Leader/Agricultural Economist (U.K)	12
- Irrigation and Drainage Engineer (Japan)	12
- Agriculturist/Farming System Agronomist (Jap)	6
- Fisheries Specialist (U.K)	6
- Sociologist/Rural Institutions Specialist (U.K.)	9

Total:	45

The Team Leader of the expatriate staff would have responsibility for the overall management of the study. The Irrigation and Drainage Engineer would spend about half of his/her time on this study (No. 12) and half on study No. 13. (Operation and Maintenance Study). The Sociologist/Rural Institutions Specialist would spend about two thirds of his/her time on study No. 12 and one third on study No. 13. The fisheries specialist may be provided by study No. 17, and advice and assistance on the environment will be supplied by study No. 16.

7.2 **The Bangladesh Team would comprise :**

		Person Month
	Project Co-ordinator (Counterpart to Team Leader).	12
Senior Specialists :		
-	In Agriculture/Agronomy, Irrigation and drainage engineering, sociology Agricultural Economics, Soil Science, Nutrition, Environment, Fisheries & Livestock.	114
Junior Specialists		
-	Junior Specialists in various disciplines for RPE, PIE and special studies	110

		Total : 236

Additional Staff :

		Person months
-	Field Supervisors (6 for 10 months for Project Impact Evaluations)	60
-	Field Assistants (24 for 8 months; 12 for 5 months; 2 for 10 months; at least for 12 of whom would be women).	272
-	Data processing and Secretarial Staff (6 for 9 months and 2 for 12 months)	78
-	Office Manager and Account (2 for 12 months).	24
-	Assistant to Expatriate Team Leaders of study Nos. 12 & 13	12

		Total : 446

Job descriptions for the Foreign Consultants and Bangladeshi Senior Specialists are given in Appendix 2. Appendix 3 outlines how the various evaluation teams would be staffed and managed.

7.3 Other input

The following other inputs would be required :

- Vehicles : 3 x 4WD & 1 x Microbus for 12 months
  3 x Motorbike for 12 months
- Computer : 6 Micro Computer; 2 printer
- Photocopier : 1 Reducing Photocopier
- Office : 4,000 Sq. Ft. Office + Utilities
- Printers, stationery and funds for workshops.