CHAPTER 5

THE PROJECT

5.1 Project Scope

Following field investigations, the rounds of public consultation, assessment of flooding problems, identification and analysis of solutions, a comprehensive development programme for Gaibandha was conceived. This has the following components:

1.	Structural Measures	-	major controlled flooding and drainage works including river training, sealing of TRE (and BRE), improvement of the Ghagot/Alai Nadi/Brahmaputra confluence.
		-	compartmentalisation and other small-scale CFD works
2.	Flood Proofing	-	on the chars and unprotected areas
		-	within the project area
3.	Associated Development	-	fisheries improvements
		-	navigation development
		-	public health

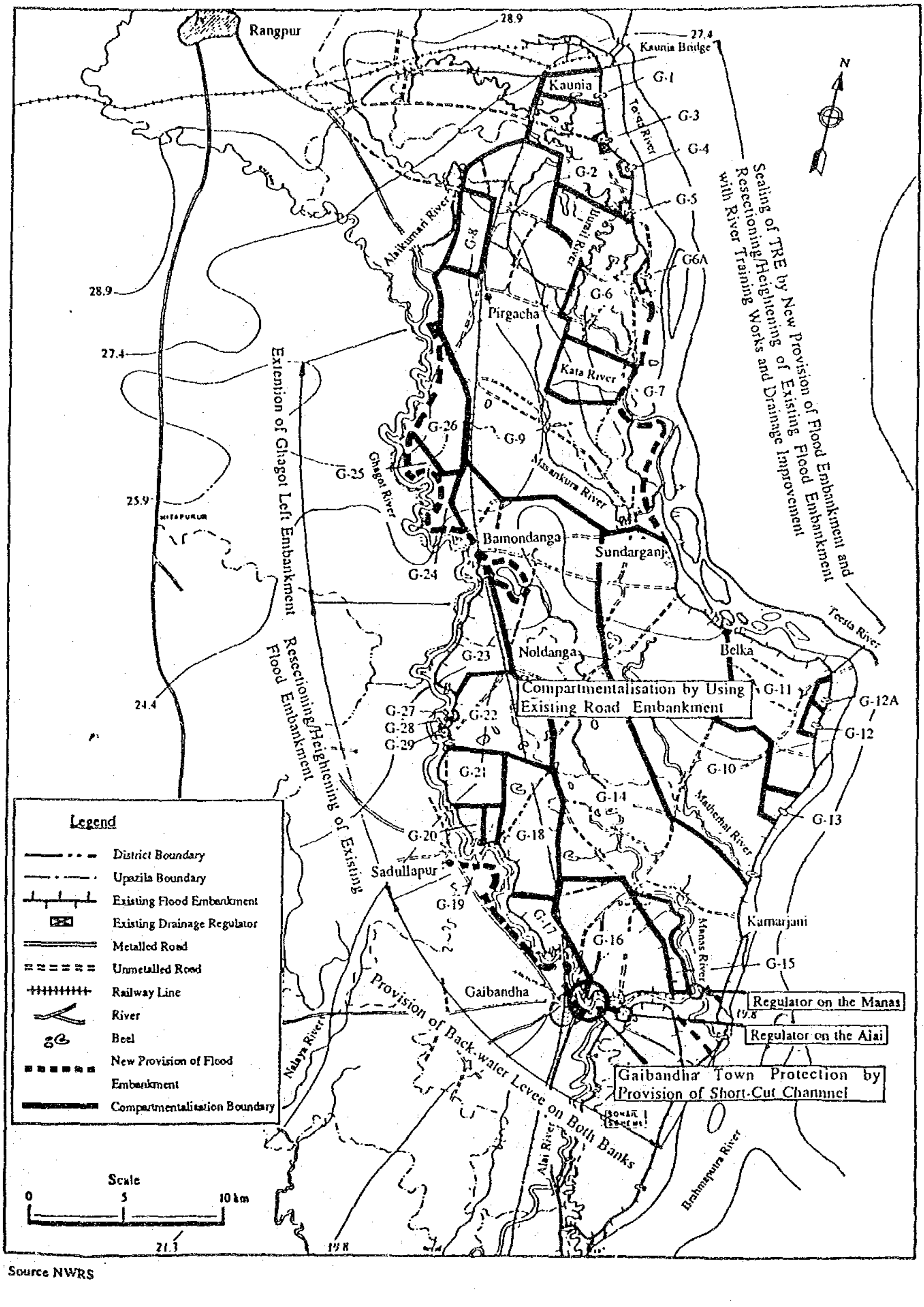
These components are discussed in the following sections.

Those carried forward for economic analysis comprise the structural measures only, with costs, benefits and dis-benefits accounted for as fully as possible. Flood proofing and associated development, many components of which have important social elements, should be considered an integrated part of the project package: however their formulation and appraisal should be considered as distinct from the project's structural measures.

5.2 Structural Measures

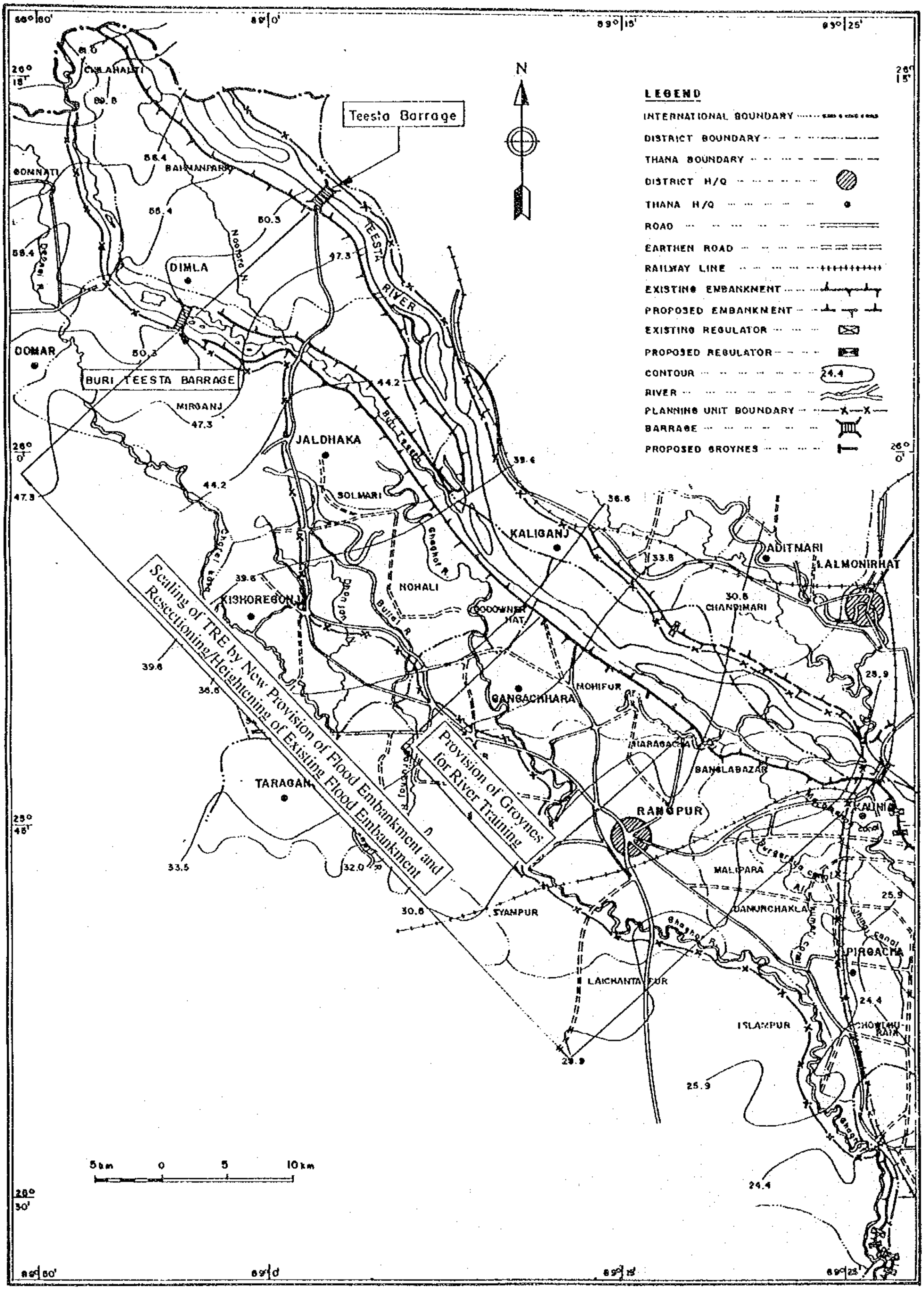
The project plan for the Gaibandha Improvement Project is composed of construction of flood embankments, river training works, channel excavation, construction of drainage structures for the GIP area including upstream reaches of the TRE from Kaunia to Teesta barrage and compartmentalisation of drainage areas. These components have been selected following the analysis of options described in the previous chapter to give the optimum configuration from the point of view of function, structure type and cost in order to achieve the objective of the plan. The components for the selected option are described below and illustrated in Figure 5.1

Figure 5.1
The Project Plan



Source NWRS

Figure 5.1 (2)
The Project Plan (Upstream TRE)



5.2.1 Major Works

River Training Works

Revetment and groynes are planned for river training works at the river stretches where severe bank erosion is expected. These works are planned for the Teesta river only based on a study of river conditions such as flood discharge, velocity, sedimentation, existing river training works and bank damage.

32 groynes are planned, with a total length of 5400 linear metres.

Flood Embankments

Flood embankment works are planned for the right bank of the Teesta river and the left and right banks of the Ghagot river. The total bank stretches are 105.9 km and 108.6 km for the Teesta river and the Ghagot river respectively. The stretches are divided into three work items, that is, provision of new flood embankment, resectioning/heightening of existing flood embankment and resectioning/heightening of existing road embankment. Existing flood or road embankments are fully utilized in the plan to lower the construction cost.

Of the embankments for the Ghagot, a stretch of 32.7 km on the right bank from the river mouth to Sadullapur functions as a backwater levee to cope with the backwater from the Brahmaputra river.

Project costs are also allowed for the strategic retirement of the BRE as required.

Major Drainage Structures and Channel Excavation

Major regulators are planned at the confluence of the Manas and the Ghagot, and at the offtake of the Alai as shown in Figure 5.2. The latter will have the effect of diverting the Ghagot flows to the Brahmaputra, once the existing Manas regulator has been eroded away.

New channel excavation is planned near the existing Manas regulator site and at Gaibandha town. The former is planned as an alternative channel for the existing Ghagot-Manas river to release water to the Brahmaputra, because it is foreseen that the existing Manas regulator will not only fail to function normally but constrain the outfall because of deterioration due to flood damage. The latter is planned as a shortcut channel to protect the town area of Gaibandha from flood from the Ghagot.

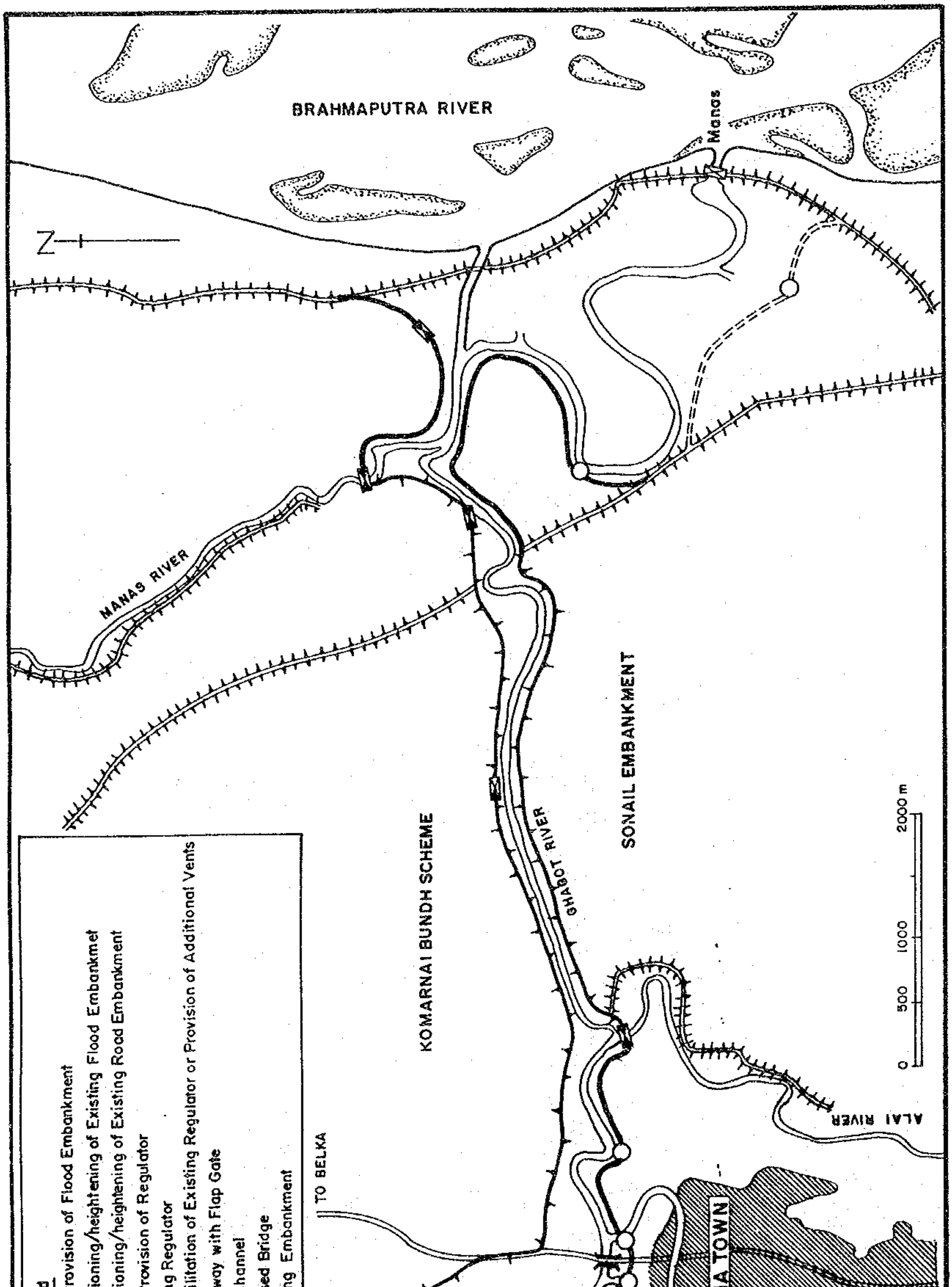
The new channel at the mouth of the Ghagot has a length of 1.2 km from downstream of the confluence the Brahmaputra. The channel is planned as a trapezoidal section with a bed width of 40 m and a side slope of 1:1. The shortcut channel at Gaibandha is planned at the site around 0.5 km distant from the north edge of town area. It has a stretch length of 0.5 km and trapezoidal section with the bed width of 30 m and the side slope of 1:1.

Drainage Structures

Regulators and sluices was are planned through flood embankments to drain out internal water to outer rivers. One regulator is planned at the most downstream portion of each sub-basin and sluice ways are planned together with side drains along embankments to drain out locally enclosed water to outer

Figure 3.2

River Layout at Ghagot Brahmaputra Confluence



rivers. Sluice ways are planned on the existing canals and also through compartment banks to secure the existing water use system. The natural drainage channels in the project area are blocked up in many places by rural road embankments. To restore the natural drainage function, drain pipes are installed at 450 points in the project area.

5.2.2 Small-Scale Works

Compartmentalization

The whole drainage area is divided into 26 sub-basins by compartment boundaries such as road embankments in order to control the concentration of rainwater and to alleviate the inundation damage in low lands. Compartmentalization is planned to fully utilize existing road banks with a significant height comparing with the design internal water level and it will be actually completed by sealing 7 existing openings such as a bridge and a culvert and providing new embankments of 6.3 km in total length. On the other hand 5 new sluice ways with control gates are provided to secure the waterway for water use during the dry season.

Other Works

Other small-scale works include the resectioning/heightering of the Ghaghot left embankment and its extension from km 43 to km 75. The proposed alignment follows existing village roads.

5.3 Flood Proofing

5.3.1 Introduction

Flood proofing conceptually includes any management measure involving no new physical structures (or only minor structural work) that will avoid or significantly reduce flood damage and adverse impacts on the productive activities of an individual household, community or private enterprise. It should, at the same time, ensure that others are not subjected to increased levels of damage by such a measure or, if so exposed, receive acceptable compensation. Thirty eight separate flood proofing measures were originally identified by FAP 23.

In the unprotected areas, major structural measures are not technically feasible and therefore the emphasis will be on flood proofing. Possible measures in these areas include:

- development of multi-purpose flood shelters on chars. This measure is seen as a priority and examples already exist of such shelters being built with a high degree of community involvement and support of local NGOs;
- flood proofing of public buildings, e.g. raised ground for schools and health centres;
- flood warning and evacuation systems.
- rehabilitation packages, e.g. for post-flood rehabilitation of farmers through provision of seeds, support for house reconstruction, etc.

It is necessary to concentrate flood proofing in the unprotected area, since this is the area of greatest need. There are numbers of different categories of communities in the unprotected area such as:

- those living on the river chars

- those living in between the flood embankment and the river bank (i.e. within the set-back distance of 1 km for TRE and 0.8 km for BRE)

- those living on the embankment (there are mostly refugees from the riverside and are therefore a consequence of lack of protection).

In the protected areas, structural measures undertaken by the project will reduce the impact of flooding, but flood proofing measures are needed to cope with effects of above-design events or structural failures. Such measures could include:

- flood proofing of public buildings;
- flood warning system;
- embankment surveillance;

In GIP, flood protection facilities are designed to protect project area from floods upto a specific flood event i.e., BRE 1 in 100 year river flood, TRE and Ghagot 1 in 20 year flood. For communities living inside the protected area, the flood proofing measures will be required depending on the design condition and the reliability of the protection offered. For flood protected areas inland, the requirement is to flood proof basic facilities from more extreme floods or from catastrophic failure of the protection facilities.

It should be noted that some of these measures (and others that could be identified such as post-monsoon reconstruction programmes) either already exist to some extent (e.g. rehabilitation schemes for farmers) and /or are likely to be implemented as part of national-level programmes.

5.3.2 Institutional Issues

The most significant factors to be addressed in relation to flood proofing are institutional. The quantities and costs of desirable measures can be easily calculated. Potentially very high costs and quantities are involved so that the flood proofing programme would be significant on a national scale and would need active government involvement and support. Moreover individuals benefiting from the programme must be fully involved. Mechanisms must be established which allow local and individual control over resources provided through government. Some experience has been gained in Bangladesh on such mechanisms and it seems clear that NGOs will have an important role to play.

In any case flood proofing and survival strategies as collective endeavour appears to be strongest where leadership and organisational inputs are provided by NGOs. On the chars and embankments around the confluence of the Teesta and Brahmaputra the Rangpur Dinajpur Rural Service (RDRS) have built high earthen platforms as part of their general development works. Inputs on leadership and group organisations are provided and the community builds platforms on a cash for works basis. The platform contains tubewells, a school and vegetable gardens. The group maintain the platform voluntarily as their contribution to the project. In the south around Gaibandha town there appear to be fewer NGOs involved in vulnerability reduction although one, Gono Unnayan Kendra (GOK), has done good flood relief and rehabilitation work with funds from Oxfam. On the TRE, the Bangladesh Rural Advancement Committee (BRAC) and the Grameen Bank are working. Other important NGOs like Service Civil International (SCI) and Mennonite Central Committee (MCC) were involved in a flood proofing project situated in Bhuapur Thana on a number of chars outside the Brahmaputra Left Embankment (BLE). As a part of an integrated development programme in the region SCI built a number of high elevated platforms to protect communities after the 1988 flood.

5.3.3 Flood Proofing Measures for the Gaibandha Project

Measures on the Chars and Unprotected Lands

High elevated earthen platforms with facilities for housing, drinking water, sanitation, etc. are required. It is proposed that 100 families are accommodated per shelter area (1,500 sqm) within the setback distance of BRE and TRE. Land acquisition cost will be relatively less compared to inside area, however the countryside location would be preferred for security reasons if the shelter can be constructed within the reservation width of the embankment. i.e. land already appropriated by BWDB.

- outside BRE (22 km) : 10 nos.
- outside TRE (24 km) : 12 nos.

Measures on the Main Embankments

Flood affected communities have been living on the existing main river embankments for the last few years. Improvement are required to reduce the distress suffered by these displaced populations. This can include flood proofing measure, as well as reviewing the policy of forbiding human habitation on flood control embankments and modifying the standard design section accordingly.

As ascertained through the surveys undertaken and the rounds of public participation in the GIP area, it is most important to provide the following facilities:

- installing about 100 nos tubewells for drinking water supplies along the 46 km of BRE, TRE and nearby chars (position to be selected depending on population density).

- arranging for the provision of about 500 nos sanitary latrines in the same location mentioned above, (one for three families).

This development should be designed to encourage the refugees to live a short distance away from the main embankments. Most of the people living on the BRE/TRE are landless and consequently seldom have any alternative land on which to live even when flood water recede. A offset platform will provide a possible solution, however it might attract more landless, either to the platforms or to the embankment locations vacated by those transferred to the platforms. The whole concept of providing a flood proofing assistance programme for those currently living on the BRE/TRE needs to be undertaken in close co-operation with BWDB, since major policy issues are involved.

Improved Road Communication

Heightening of existing village roads above flood level outside the GIP is require for transport of flood affected people, livestock etc. from surrounding flooded areas. For the communities within the protected area, compartment boundaries are considered adequate for basic flood proofing.

Heightening of roads (outside BRE and TRE)

- outside BRE : 5 km; average height 1.5 m
- outside TRE : 7 km; average height 1.0 m

Construction of Relief Centres

Construction of new two-storied buildings, extending existing primary school buildings or the construction of single storied food storage godown buildings will serve as emergency relief centre. These multi purpose buildings can be used for education, community development centre, medical treatment etc.

Food storage godown (in & outside GIP, 150 sqm)	:	3 nos.

The siting of the structures should be in a protected location but near an affected area. One is recommended at Bholanathhat under Sundarganj thana and others are proposed in Haripur (confluence of Teesta & Brahmaputra) and Dhariapur (southern part of GIP).

The Structural Programme

The costs and scope of a programme to serve all the flood-prone population in the Gaibandha area would be enormous. As discussed in the Regional Plan Final Report it is estimated that some 100 000 people live on the chars and unprotected area and a further 70000 along the embankment. This would require about 170 shelters on the unprotected areas and around 500 tubewells and 3000 latrines along the embankment. The cost of this alone would be of the order of Tk.75 million, without any allowance for improved road communication and relief centres.

As a pilot trial it is therefore proposed that an initial sum of Tk.10 million be allocated. This would be primarily allocated for the construction of 20 shelters on the unprotected lands (Tk. 8 millions) together with 3 relief centres within the project area but close by (Tk. 1 million) and some water and sanitation provision on the main embankments (Tk. 1 million).

Non-structural measures

The following non-structural measures are also effective for flood proofing in and outside the GIP area:

- security patrols at communities concerned with flooding;
- promotion of flood proofed buildings for public buildings such as schools, hospitals, etc. at the downstream end of internal rivers where deep inaundation water usually covers, especially the Manas, and areas outsite the TRE and BRE;
- stockpiling of foods and fuel for emergency and seed and nursery beds and other farmer recovery aids in the areas along the TRE and BRE;
- establishment of embankment surveilance groups along the Ghagot, Teesta and Brahmaputra;
- establishment of flood communication, flood forecasting, warning and evacuation sytems covering the GIP and outside areas;
- land use regulations based on flood hazard zoning and education to increase awareness of flooding risk.

The measures discussed need consultation and support at each government level from institutional, organizational and financial aspects so as to ensure their effective implementation. Therefore, the actions should be carried out on a regional or national scale.

5.4 Associated Development

5.4.1 Fisheries

The following possible measures are specific to the project. Measures appropriate to the whole region are discussed in the Fisheries Report, Volume 12 of the Draft Final Report.

Preservation and Improvement of Khas Water Bodies

It is proposed that funding should be included under the provision for mitigatory measures, for the improvement of Kachuadha, Bamandanga, Maruadha, Satrail and Hurudanga beels and a perennial section of the Matherhat Canal, all of which are located inside the GIP perimeter (Figure 5.3).

Improvement should take the form of the excavation of silted up areas around the edges of the beels, using the spoil to raise bunds within which the area and depth of permanent water can be increased, thereby expanding productivity and the numbers of fishermen who can be supported by these fisheries. The work should be jointly supervised by local BWDB and DOF officers and NGO assistance should be sought to help organise the fishermen into groups or associations. The cost of supplementary stocking, after completion of the physical works, should also be included.

Cost are estimated as follows:

-	excavation and construction of about 25 km of low bunds around the beels, 200,000 cu.m. @ Tk. 46	Tk.	9,200,000
-	fish stocking, 65 ha x 5000/ha @ Tk. 600 per 1000 fingerlings	Tk.	200,000
-	travel, supervision & misc. @ 15%	Tk.	1,400,000
	Total:	Tk.	10,800,000

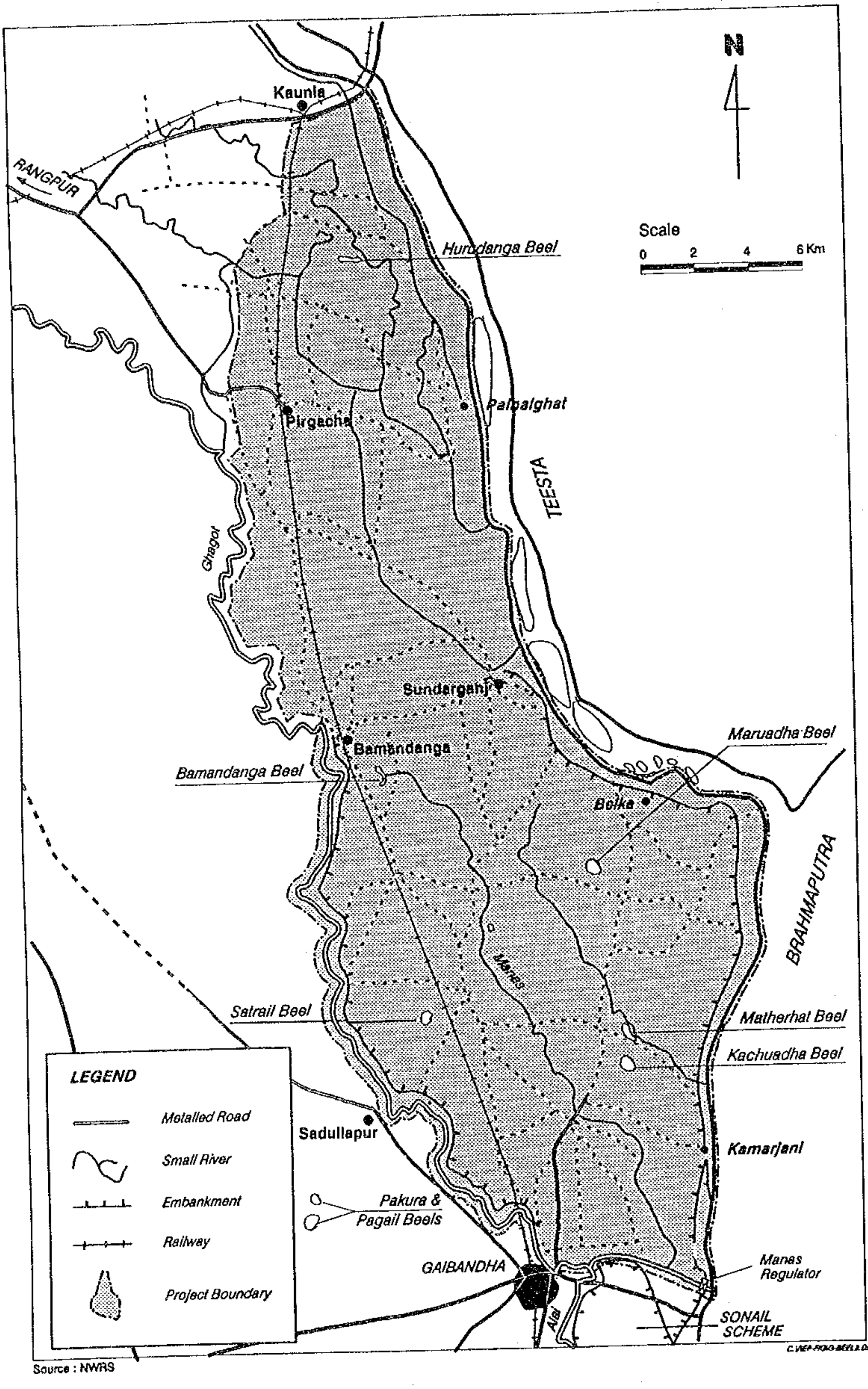
The investment would generate additional fish production from the beels totalling about 80 mt. per year, worth at least Tk. 3.2 million to the fishermen and providing employment opportunities for at least 60 additional fishermen.

Development of Borrow-pit Fisheries

In the course of constructing embankments, roads and other facilities, a very large area and number of borrow-pits have been dug with little or no though given to their possible productive use afterwards. It costs no more to plan the shape and depth of the borrow-pit and ensure compliance by the contractors, than it does to allow them to leave the area as an unusable derelict wasteland. In parts of the GIP area the ground is too porous and borrow-pits too shallow to hold water long enough to produce a fish crop, but the district fishery officer estimates there are at least 200 ha of potentially productive old borrow-pits within GIP.

Figure 5.3

Beel Improvements



Source : NWRS

It is proposed that these areas should be excavated under similar administrative arrangements as above, stocked and allocated to the use of NFMP fishermen's groups, again with appropriate NGO assistance. Initially a pilot trial of 20 ha should be undertaken.

Costs are estimated as follows:

-	excavation of 20 ha @ Tk. 5 lakhs/ha		Tk. 10,000,000
-	stocking @ 5000/ha; Tk.600/1000		Tk. 600,000
-	travel, supervision & misc. @ 15%		Tk. 1 600,000
		Total:	Tk. 12,200,000

On the assumption that these areas currently produce little or no fish, the investment could generate additional production of about 160 mt. fish per year, worth Tk. 6.4 million to the fishermen and provide work for at least 200 fishermen.

Modified FCD Structures

Designs for modifying or rebuilding sluices, regulators and other FCD structures so as to permit two way traffic by fish stocks, without jeopardising the protective function of the flood control structure, are still being studied by FAP 17. Possible modification methods might be a fish ladder with small gates as a cheaper solution, provision of additional gates and concrete works for a regulator which needs higher cost, and so on. Figure 5.4 shows a conceptual design for modification of regulators by means of provision of additional gates to migrate fish fry and mature fish, during the breeding period and monsoon season, in which option 1 provides double leaf gates for regulator to generate free surface flow but small amount of discharge, while in option 2, river and country side gates are operated as indicated in the figure; namely one is open and the other is closed with an appropriate time cycle. The required cost for modification is about Tk 1,300,000 per regulator for both options including physical contingency and engineering services, and Tk 17 million correspond to 1% of the project cost is required for modifying the existing and proposed regulators in the comparatively expensive case. Monitored pilot trials are required of perhaps several possible designs including such modifications, to determine their effectiveness. Until such trials have been completed by FAP17 it is not considered sensible to make any specific proposals for GIP. However, it is suggested that token provision be included in GIP estimates so that the position can be kept under review pending FAP 17 reaching some conclusions.

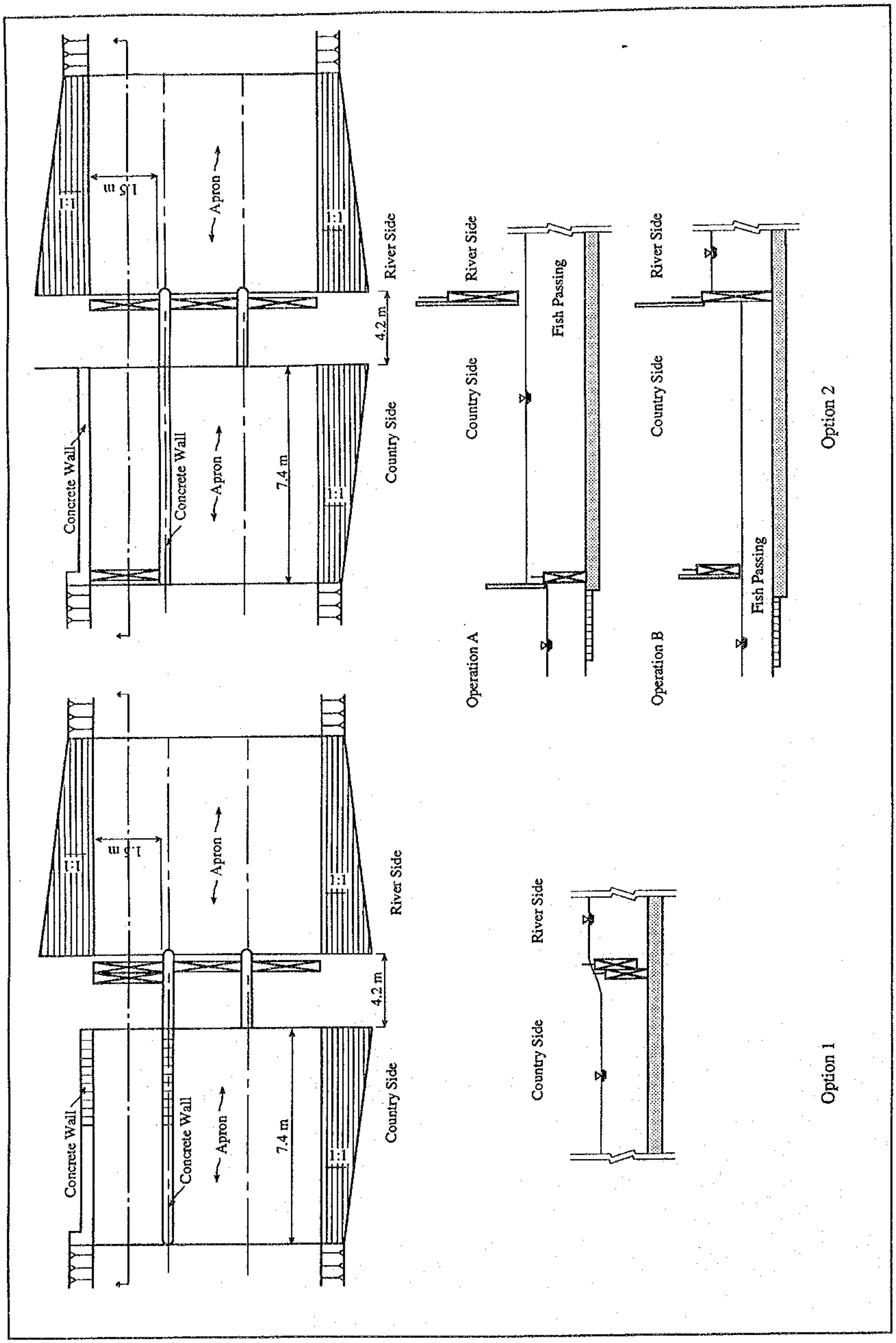
Enhancement of Capture Fish Resources

It has already been proposed that provision be included for restocking certain beels and borrow-pits. Third Fisheries Project (TFP) is likely to extend its beel restocking programme into Gaibandha District and several other beels in the area have already been partially improved with FFW assistance in readiness. Bearing in mind that GIP is likely to have external impacts as well as impacts on internal fisheries, it is proposed that GIP provision should also include funding for supplementary stocking in floodland areas in the eastern part of Sadullapur thana and in Shaghata thana, which could suffer from the effects of embanking the Ghagot right bank and the Alai regulator.

For these reasons it is proposed that Pakuria and Pagail beels in Sadullapur, and Telian Beel and Bill Basta Beel in Saghata should also be restocked. Ideally the restocking programme should include enhancement of fish stocks in the Ghagot River itself but the technology for doing this effectively has

Figure 5.4

Possible Fish Pass Structures



still to be established. This is a further matter on which FAP 17 should produce useful advice in due course, so in the meantime only token provision is proposed.

Costs are estimated as follows:

-	Restocking Pakuria, Pagail, Telian and Bill Basta Beel, 162 ha x 5000 x 600		Tk. 500,000
-	travel, supervision, etc.		Tk. 75,000
		Total :	Tk. 575,000

The project should generate an extra 32 mt. fish worth Tk. 11.3 million to the fishermen and possibly provide an additional 20 jobs for fishermen.

Fish Farming Opportunities

Increased protection from flooding, whether from river water or from rainfall congestion and thus a reduction in the risk of ponds being overtopped and fish swept away by flood water, creates the opportunity to restock any ponds that are in suitable condition, and to rehabilitate others that have fallen into disuse and become derelict. However, experience from other projects (as described in FAP 12 reports) shows that the response has often been disappointing mainly because of DOF's inability to field the necessary extension effort to give pond owners the right advice and the general lack of access to low cost rural credit to cover the costs of pond rehabilitation or new pond construction.

A further problem in GIP is high soil porosity, particularly in the southern half, and the consequent need to dig very deeply for year-round water which adds greatly to costs. Conditions are more favourable in the northern half of GIP, and it is here that efforts should concentrate in the earlier years. The project could provide some support, eg transport for extension workers and for their training as and when needed, at the new Parbatipur aquaculture centre.

Costs are estimated as follows:

-	Transport & training of field staff		Tk. 400,000
-	200 bicycles @ Tk. 5000		Tk. 100,000
		Total :	Tk. 500,000

Benefits of extension efforts are difficult to quantity but if the average yield of existing cultured ponds can be increased by 18-20% and half of the derelict ponds can be made productive again, they could produce at least 80 mt. p.a. more than now, worth Tk. 4 million to the pond owners.

5.4.2 Navigation

A preliminary study was carried out of improving inland water transport in the GIP area during the monsoon season. This would be done by building a navigation lock at each of the regulator sites located at the downstream end of the Masankura, Matherhat and Manas rivers, which are possible navigation routes. In addition, the river channels to be used for navigation purpose will have to be excavated over a bed width of 10 m at least to cope with silting problem which will also hamper the smooth navigation

planned in order to secure the sectional area of channel for navigation of the boat. The channel stretches to be excavated are as follows:

-	Masankura to Pirgacha	:	15.0 km
-	Matherhat to Sundarganj	:	31.8 km
-	Manas to Bamondanga	:	37.2 km

The total of the excavated volume in these channels amounts to approximately 1.68 million m^3.

The approximate cost for the structures and dredging is Tk. 152.5 million including 25% contingencies, and engineering and supervision costs.

Preliminary calculations of the returns to such investments were described in the Volume 5 of the Draft Final Report. These suggest that further detailed study of navigation potential might be justified. The calculations were made considering only two commodities, jute and rice, although these are the most important bulk exports out of the area. However, increased trade out of the area can be expected to stimulate trade into the area, so that potential sources of cargo could be increased. In terms of the volumes of paddy and jute requiring to be shipped, it is not clear that they will be reached. The paddy volume is not large in relation to the total paddy area, but Gaibandha is not a major paddy exporter. Most jute is exported out of the area, but at present much of the jute is carried by truck.

It was concluded that the scope of any navigation improvement requires more detailed work. The works costed in the preliminary analysis may not all be necessary, and the navigation concept could be changed, e.g. transhipment points could be created at the site of the regulators so that small boats could still operate inside them. Apart from the potential for economic benefits, there are also significant potential gains in terms of local income and employment. It was therefore proposed that the scope for navigation should be explored in detail in the next phase of project preparation. For the interim, a figure of Tk 150 million was included in the associated project costs for navigation improvement.

The draft final report contains details of the results of the preliminary analysis.

5.4.3 Health

The environmental survey of the project area (Section 7. 2) identified significant water-related health problems, which would be impacted by the project works. At the present there is insufficient data to allow detailed mitigation measures to be proposed. It is therefore recommended that the associated project costs should include a notional amount for study, design and implementation of any necessary health measures.

5.5 Project Costs

The project cost for structural works within the GIP area is estimated at the feasibility study level but it is noted that the costs for sealing of upstream TRE and the proposed associated development projects are still at the preliminary study level. Therefore, further studies including investigations and surveys are needed in the next stage to establish the definitive plan for these components and for updating the cost estimated at this stage.

The project costs for structural measures estimated at September 1992 prices are summarized in Tables 5.1. These costs are based on the manual construction method for earth works. Details are given in volume 6 of the Draft Final Report.

Table 5.1 Project Cost - Structural Works (Tk. '000)

Cost Items	Foreign Currency	Local Currency	Total
1. Major Works			
Construction Cost	305,153	745,399	1,050,552
Administration Cost	0	31,516	31,516
Physical Contingency	57,373	141,081	198,454
Engineering Supervision	43,502	106,944	150,446
Land Acquisition	0	98,219	98,219
Sub-Total	406028	1,123,159	1,529,187
2. Minor Works			
Construction Cost	24,962	68,286	93,248
Administration Cost	0	2,798	2,798
Physical Contingency	3,744	10,243	13,987
Engineering Supervision	2,871	7,853	10,724
Land Acquisition	0	20,136	20,136
Sub-Total	31,577	109,316	140,893
3. Total Project Cost			
Construction Cost	33,0115	813,658	1,143,800
Administration Cost	0	34,314	34,314
Physical Contingency	6,1117	151,324	212,441
Engineering Supervision	46,373	114,797	161,170
Land Acquisition	0	118,355	118,355
Total	437,605	1,2,32,475	1,670,080

Costs for flood profing and associated development are given in Table 5.2.

Table 5.2 Project Cost - Flood Proofing and Associated Development (Tk. '000)

	Description	Project Cost
1.	Flood proofing	10 000
2.	Preservation and improvement of Khas water bodies	10 800
	Development of borrow-pit fisheries	12 200
	Modifications to structures	10 500
	Enhancement of capture fisheries	575
	Fish farming opportunities	500
	Round Total, Fisheries	35 000
3.	Navigation	150 000
	Total Associated Development	195 000

It is noted that these are preliminary estimates of costs in order to get an indication of the order of magnitude of the sums involved. Further work would be needed at the planning and detailed design stage to refine the estimates. Also the cost for non-structural flood proofing measures are not included in the above table.

5.6 Implementation Schedule

The implementation schedule for the structural works is based on phasing of the works. The first phase will include the major works required to prevent spilling from the Teesta, which will also reduce flooding risk from the Ghagot. These are the main sources of flooding and provide the greatest part of the benefits. The second phase will mitigate the drainage congestion at the lower part of the Ghagot caused by the insufficient flow capacity of the Alai and insufficient discharge capacity of the existing Manas regulator which is being eroded and expected to be washed away within a few years. This work will also provide great benefit to the lower part of the Ghagot and Manas. In regard to the second phase, it is necesssary to observe the erosion situation of the Manas regulator and to integrate the FAP2 and FAP 21/22 Proposals (FAP21/22 selected the Manas regulator site as a pilot project for bank protection works). Internal works, whilst an important part of the project, provide a smaller part of the benefits and clearly need further data accumulation and studies (especially on the hydraulic modelling with/without sealing Teesta and on social impacts through further rounds of public participation) before detailed design and implementation can take place.

Additional reasons for phasing include the intention of smoothing the annual disbursement of funds as much as possible, and aiming to ensure that parts of the works being undertaken do not worsen flooding conditions elsewhere.

The proposed programme is shown in Figure 5.5. Works in the first phase are concentrated on the sealing of the Teesta, since this will have the greatest benefits both for the project, and for the region. Phase 2 consists of construction of the backwater embankment at the downstream end of the Ghaghot. Phase 3 consists of the extension of the Ghaghot left embankment upstream and the compartmentalisation works.

It should be noted that the phasing allows a considerable period of pre-construction activities. Construction work on the Teesta is expected to begin after two years, and on compartmentalisation after eight. There is thus sufficient time available for further investigations, the formation of the Project Management Unit (see Section 8.1), the establishment of LCSs, monitoring and modelling of compartmentalisation. The design of compartmentalisation in particular must wait unit the impacts of Teesta sealing becomes known.

Table 5.3 shows the phasing of costs for the structural works.

Table 5.3 Project Financing Schedule - Structural Works

(Tk million)

Year	Foreign	Local	Total
1	12.06	29.61	41.67
2	12.06	42.37	54.43
3	59.85	158.27	218.13
4	115.32	284.52	399.84
5	133.83	336.33	470.16
6	56.28	174.18	230.45
7	13.99	77.35	91.34
8	5.52	30.03	35.55
9	11.88	29.81	41.69
10	18.41	41.93	60.34
11	8.37	18.12	26.49
Total	447.56	1222.52	1670.08
$mn	12.43	33.96	46.39

Figure 5.5

Implementation Schedule

Development Projects	Year 1	2	3	4	5	6	7	8	9	10	11
A. FCD development											
Phase 1 Sealing of TRE with river training works											
a) Upstream of Kaunia	Pre-design	Detailed Design	Construction	Construction	Construction	Construction					
b) Downstream of Kaunia	Detailed Design	Detailed Design	Construction	Construction	Construction	Construction					
Phase 2 Construction of backwater levee along Ghagot and Gaibandha town protection (Left bank: 25.0 km, Right bank : 32.7 km)											
a) Observation of erosion situation at Manas regulator site	Observation	Observation									
b) D/D and construction			Detailed Design	Detailed Design	Construction	Construction	Construction	Construction			
Phase 3 a) Resectioning/heightening of existing Ghagot left embankment (25.0 km to 43.0 km)							Detailed Design	Detailed Design	Construction	Construction	Construction
b) Extension of Ghagot left embankment (43.0 km to 75.9 km)							Detailed Design	Detailed Design	Construction	Construction	Construction
c) Compartmentalisation (576 sq.km)											
• Hydraulic and hydrological observation for model updating	Observation	Observation	Observation	Observation	Observation	Observation					
• Public consultation					Observation	Observation	Observation	Observation			
• D/D and construction							Detailed Design	Detailed Design	Construction	Construction	Construction
BRE Retirement and strengthening	Construction	Construction	Construction	Construction	Construction	Construction	Construction	Construction	Construction	Construction	Construction
B. Flood proofing											
a) Formulation of flood proofing programme	Study	Study									
b) Unprotected area			Construction	Construction	Construction	Construction					
c) Protected area							Construction	Construction	Construction	Construction	Construction
C. Associated development											
a) Fisheries	Study	Study	Construction	Construction	Construction	Construction	Construction	Construction	Construction	Construction	Construction
b) Navigation	Study	Study	Construction	Construction	Construction						
c) Health	Study	Study	Construction	Construction	Construction	Construction	Construction	Construction	Construction	Construction	Construction

Legend:
- Study for formulating development or improvement programme
- Pre-design
- Detailed Design
- Construction/Implememntation
- Observation works/consultation and monitoring

Flood proofing work and associated development projects of fisheries, navigation and health are planned to be implemented in parallel with the FCD works during the project implementation period as shown in Figure 5.5. Further analyses and studies are recommended to formulate definitive development or improvement programmes before implementation. Table 5.4 shows an indicative disbursement schedule for the associated development.

Table 5.4 Project Financing Schedule - Associated Development

(Tk. million)

Year	Fisheries	Navigation	Flood Proofing	Total
1	3.2	30	0.9	34.1
2	3.2	30	0.9	34.1
3	3.2	30	0.9	34.1
4	3.2	30	0.9	34.1
5	3.2	30	0.9	34.1
6	3.2		0.9	34.1
7	3.2		0.9	34.1
8	3.2		0.9	34.1
9	3.2		0.9	34.1
10	3.2		0.9	34.1
11	3.2		0.9	34.1
Total	35	150	10	195

CHAPTER 6

ECONOMIC ANALYSIS

Economic analysis was used both to assess the viability of the selected option and, at an earlier stage, to assist in the choice between options. Sensitivity analyses to test specific alternatives within the selected option were also carried out. Some partial analyses were conducted, for example to assess the viability of measures to assist navigation development.

This chapter reports briefly on the methodology used for analysis (which is discussed in greater detail both in the Regional Plan Main Report (Volume 1) and the Economics Annex (Volume 13) of the Draft Final Report), and then reports and discusses the main results of analysis.

6.1 Methodology

The approach to analysis has closely followed the recommendations in the FAP Guidelines for Project Assessment. The main addition to those recommendations has been the use of a scarcity premium in the economic valuation of fish output: this has been one area of analysis where it has been possible to extend the conventional cost-benefit approach to take account of long-term processes. In most other respects such an extended cost-benefit approach has not proved possible, but a multi-criteria analysis has been carried out to integrate the economic analysis and other impacts which could not be valued.

The main components which have been included in the economic analysis are:

A. Project costs
- construction and O & M costs
- economic cost of land acquisition
- costs of embankment retirement along the Brahmaputra

B. Project benefits/disbenefits
- crop intensification benefits
- benefits/disbenefits for fisheries
- benefits of reduced crop and non-crop flood damage
- benefits from avoidance of erosion losses on the Teesta River

The benefits/disbenefits have, as much as possible, been evaluated both for the impacted area as well as for the project area.

6.2 Benefit Assessment

6.2.1 Estimation of Incremental Crop Production Benefits.

Cropping Patterns

The incremental crop production benefits arise from shifts in cropping patterns due to changing flood levels induced by project developments. The extent of changes in water levels, and how these will affect the selection of cropping patterns, needs to be derived.

Two alternative approaches were undertaken in the analysis to establish the link between changes in water levels and changes in cropping patterns. These approaches are briefly described here.

The first approach (described in detail in the Volume 12, Agriculture, of the Draft Final Report) makes full use of the Gaibandha hydro-dynamic model: selection among the important crops (mostly paddy crops) is determined according to certain rules which effectively set constraints to production based on the depth and timing of floods. The model output is therefore directly utilised to predict cropping patterns in both future-without and future-with conditions.

The second approach is based more on the flood phase system developed by MPO (now WARPO) and on BBS published cropped area statistics. This approach, described in more detail in the Regional Plan Final Report and in Volumes 12 and 13 of the Draft Final Report, only utilises the model indirectly, by using it as a guide to the extent and direction of changes in flood phasing as a result of the project.

Both approaches were used in the period leading up to the Draft Final Report. They generate slightly different results in the analysis, primarily because flood phase analysis suggests a (small) switch of F1 to F0 land, allowing some replacement of local t.aman by HYV t.aman. While both approaches have merit, at present the second (MPO) approach probably gives more reliable results, and was finally used in assessing cropping pattern changes due to the project. Cropping patterns by flood phase for future without and future with are shown in Figure 6.1 and detailed in Table 6.1.

It should be noted that the benefitted area includes the area downstream of the Alai regulator, i.e. immediately south of the project area. Benefits in that area are expected to arise not only from reduced crop damage (discussed below), but also from changes in flood phasing and cropping patterns. The hydro-dynamic model and drainage analysis were used to calculate the changes in flood phasing likely to occur in the area, and cropping pattern changes were then calculated and included in the analysis. Since the southern part of this area lies on the left bank of the Upper Karatoya, care was taken in the model and drainage analysis to distinguish between changes due to upstream developments and those due to the proposed Bangali Floodway development downstream being considered under the regional plan.

Based on the flood phase analysis, the value (in economic prices) of with-project net agricultural returns is Tk. 986 mn (an increase of about Tk. 47 mn over without-project conditions) in the Gaibandha project area, and Tk. 320 mn (an increase of Tk. 41 mn) in the Alai basin. The proportionate increase is therefore larger in the Alai basin.

Input-output data for the economic analysis are unchanged from those used in the regional planning analysis. Prices, yields etc. are generally not very different from those prevailing elsewhere in the region. The main possible source of difference could be wage rates. It is known that Gaibandha is an area of high underemployment and seasonal out-migration where wages are low. The agro-economic survey conducted by NWRS indicates daily wage rates of about Tk 20-30. Nonetheless, the financial wage rate assumed in the regional plan is only Tk 30, i.e. in the upper range of observed wages in Gaibandha, and therefore the assumed financial wage rate for Gaibandha of Tk. 30 is reasonable.

Table 6.2. shows physical input-output data used in the analysis, Table 6.3. shows financial and economic prices of inputs, Table 6.4. shows financial and economic prices of outputs, and Table 6.5. shows per hectare gross and net returns by crop.

Figure 6.1
Cropping Diagrams

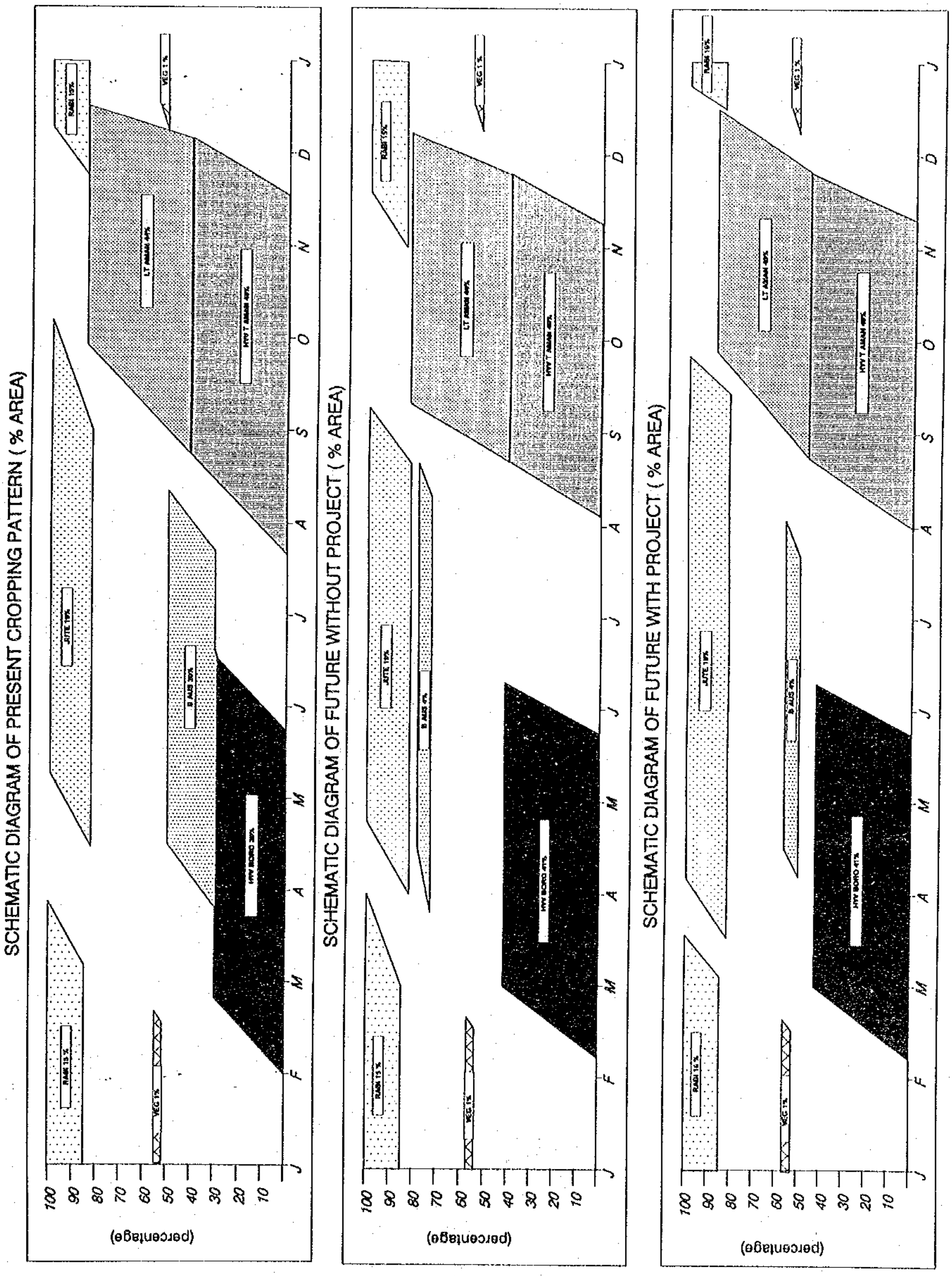


TABLE 6.1(a) FUTURE WITHOUT CROPPING PATTERNS BASED ON FLOOD PHASE ANALYSIS

LAND TYPE	AMOUNT(HA)
F0	15230
F1	25056
TOTAL	40287
F2	5404
F3	2948
TOTAL	8352
F4	491
GTOYAL	49130

IRRIGATION BALANCE	
HYV BORO	20143
WHEAT	0
HYV AUS	0
TOTAL	20143

DISTRIBUTION OF LAND BY IRRIGATION STATUS BY FLOOD PHASE

LAND TYPE	IRRIGATE AREA	NONIRRI AREA	TOTAL AREA	% IRRIG
F0	3415	11815	15230	22
F1	10022	15034	25056	40
TOTAL	13437	26849	40286	33
F2	4053	1351	5404	75
F3	2653	295	2948	90
TOTAL	6706	1646	8352	80
F4			491	
TOTAL	20143	28987	49130	41

CROPS ON F0+F1

RABI SEASON		AUS SEASON		AMAN SEASON		ANNUAL CROPS	
HYV BORO	13437	B. AUS	716	HYV TAMAN	19468	SUGARCAN	223
WHEAT	3009	HYV AUS	0	L.T. AMAN	21396	ORCHARDS	22
POTATO	55	JUTE	9000	VEGETABLES	100		
TOBACCO	442	OILSEEED	0	SPICES	0		
PULSES	1766	SPICES	0				
OILSEED	0	VEGETAB	232				
SPICES	0						
VEGETABLES	322						
Sub-Total	19031	Sub-Total	9948	Sub-Total	40964	Sub-Total	245
Total	70188						
CROPPING INTENSITY	174						

CROPS ON F2 LANDS

HYV BORO	4053
DW AMAN	0
AUS	1169
WHEAT	1351
OILSEED	200
PULSES	118
JUTE	182
L.BORO	0
Total	7073
CROPPING INTENSITY	131

CROPS ON F3 LAND

HYV BORO	2653
LOCAL BORO	0
D.W.AMAN	242
OILSEED	548
Total	3443
CROPPING INTENSITY	117

TOTAL CROPPING INTENSITY 164%

TABLE 6.1(B) FUTURE WITH CROPPING PATTERNS BASED ON FLOOD PHASE ANALYSIS

LAND TYPE	AMOUNT(HA)		IRRIGATION BALANCE	
F0	19652		HYV BORO	20143
F1	23091		WHEAT	0
TOTAL	42743		HYV AUS	0
F2	3439			
F3	2457	49130	TOTAL	20143
TOTAL	5896			
F4	491			
GTOYAL	49130			

DISTRIBUTION OF LAND BY IRRIGATION STATUS BY FLOOD PHASE

LAND TYPE	IRRIGAT AREA	NONIRRIGA AREA	TOTAL AREA	% IRRIG
F0	6116	13536	19652	31
F1	9236	13855	23091	40
TOTAL	15353	27390	42743	36
F2	2579	860	3439	75
F3	2211	246	2457	90
TOTAL	4791	1105	5896	81
F4			491	
TOTAL	20143	28987	49130	41

CROPS ON F0+F1

RABI SEASON		AUS SEASON		AMAN SEASON		ANNUAL CROPS	
HYV BORO	15353	B. AUS	1025	HYV TAMAN	23552	SUGARCANE	223
WHEAT	3991	HYV AUS	0	L.T. AMAN	19718	ORCHARDS	22
POTATO	55	JUTE	9000	VEGETABLE	100		
TOBACCO	442	OILSEEED	0	SPICES	0		
PULSES	1884	SPICES	0				
OILSEED	0	VEGETABLE	232				
SPICES	0						
VEGETABLES	322						
Sub-Total	22047	Sub-Total	10257	Sub-Total	43370	Sub-Total	245
Total	75919						
CROPPING INTENSIT	178						

HYV BORO	2579
DW AMAN	0
AUS	860
WHEAT	860
OILSEED	300
PULSES	0
JUTE	182
L.BORO	0
Total	4781
CROPPING INTENSIT	139

CROPS ON F3 LAND

HYV BORO	2211
LOCAL BORO	0
D.W.AMAN	242
OILSEED	448
Total	2901
CROPPING INTENSIT	118

TOTAL CROPPING INTENSITY 170%

Table 6.2 Physical Input Quantities per hectare, NW Region. Future Condition

Present Crop	Labour (man days)	Draft Animal (pair days)	Seed (kg)	Fertiliser Urea (kg)	TSP (kg)	MP (kg)	Manure (kg)	Pesticide (kg)	Production (kg/ha) Main Crop	(mt/ha) By-Product
HYV Boro	215	50	30	210	139	46	0	0.5	5.175	5.175
Local Boro	160	40	30	63	42	14	0	0	2.625	2.625
HYV Aus	205	50	30	149	103	34	0	0.5	4.3125	4.3125
Local B.Aus	160	45	80	55	0	0	1300	0	1.68	1.68
HYV T.Aman	190	50	30	149	103	34	0	0.5	4.3125	4.3125
Local T.Ama	140	44	30	49	33	11	1300	0	2.3625	2.3625
DW Aman	115	45	30	55	0	0	660	0	1.68	2.52
Wheat	120	40	140	80	26	0	0	0.25	1.785	1.785
Jute	230	48	7	64	21	16	0	0	1.785	3.57
Sugarcane I	260	65	5000	187	75	112	1400	0.75	44.1	
Sugarcane II	230	65	5000	50	20	30	1400	0	20	
Potato	190	45	1000	79	53	79	1500	0.5	10.5	
Pulse	50	30	30	31	0	0	0	0	0.84	1.05
Oilseeds	75	36	10	79	79	32	700	0.5	0.735	1.05
Onion	150	40	6.2	58	39	58	0	0	8.4	
Vegetable (Brinjal)	270	50	0.3	66	44	66	0	0	15.75	
Tobacco	260	60	0.1	0	26	26	2600	0.5	1.05	
Banana										

Sources:

(1) MPO Technical Report No.14.

(2) World Bank:Bangladesh:Selected Issues in Rural Employment (1983).

(3) Agro-Economics Research,MoA:Costs and Returns for years 1982-83 to 1988-89

(4) IFDC Farm-Level Fertiliser Use Surveys for 1989/90 Rabi/Boro and Aman Seasons.

(5) Consultants' field survey data.

Table 6.3 **Financial and Economic Prices for Inputs,NW Region,mid 1991.**

Input	Financial Price (Tk)	Conversion Factor	Economic Price (Tk)
Labour(m-d)	31.67	0.75	23.75
Draft power (pair-days)	25.00	0.87	21.75
Urea(kg)	5.12	1.17	5.99
TSP(kg)	6.60	1.34	8.84
MP(kg)	5.55	1.45	8.05
Manure(kg)	5.00	0.87	4.35
Pesticide (Kg)	504.00	0.87	438.48
LLP(ha)	2732.00		2068.00
STW(ha)	6611.00		4736.00
DSSTW(ha)	7324.00		5182.00
DTW(ha)	10883.00		6653.00
SEEDS: (Kg.)			
HYV Boro	9.92	0.88	8.73
Local Boro	9.92	0.88	8.73
HYV Aus	8.76	0.88	7.71
Local B.Aus	8.76	0.88	7.71
HYV T.Aman	9.60	0.88	8.45
Local T.Aman	9.48	0.88	8.34
B.Aman	9.48	0.88	8.34
L.I.Aman (Paijam)	9.48	0.88	8.34
Wheat	10.11	1.29	13.04
Jute	25.71	1.06	27.25
Sugarcane		0.95	
Potato		0.87	
Pulse	24.50	0.87	21.32
Mustard/Rape	19.89	0.88	17.50
Onion		0.87	
Vegetable (Brinjal)		0.87	
Tobacco		0.87	

Source: NWRS Estimates

Conversion factors from GPA except for revised fertiliser factor

Table 6.4 Financial and Economic Prices for Crops, NW Region, 1991-92

Crop	Financial Price (Tk/kg)	Conversion Factor	Economic Price (Tk/kg)
HYV Boro	6.61	0.88	5.82
Local Boro	6.61	0.88	5.82
HYV Aus	5.84	0.88	5.14
Local B.Aus	5.84	0.88	5.14
HYV T.Aman	6.40	0.88	5.63
Local T.Aman	6.32	0.88	5.56
B.Aman	6.32	0.88	5.56
L.I.Aman (Paijam)	6.32	0.88	5.56
Wheat	6.74	1.29	8.69
Jute	8.57	1.06	9.08
Sugarcane		0.95	
Potato		0.87	
Pulse	16.33	0.87	14.21
Mustard/Rape	13.26	0.88	11.67
Onion		0.87	
Vegetable/(Brinjal)		0.87	
Tobacco		0.87	
Rice Straw - HYV	0.70	0.87	0.61
Rice Straw - Local	0.93	0.87	0.81
Jute Sticks	2.73	0.87	2.38

Source: NWRS Estimates
Conversion factors from GPA

Table 6.5 Adjusted Crop Budgets (Economic Prices) (Tk./ha, 1991-92 prices)

Crops	Gross Return (excl.crop residues)	Cost of Inputs	Irrigation Cost	Cost of Credit (12%)	Miscell. Costs (10%)	Total Production Cost	Net Return
HYV Boro	30119.00	9532.00	4262.00	662.11	1445.61	15901.72	14217.28
HYV T.Aman	24282.00	8149.00	474.00	413.90	903.69	9940.59	14341.41
DW Aman	9526.00	4362.00	0.00	209.38	457.14	5028.51	4497.49
L.T.Aman	13138.00	5349.00	0.00	256.75	560.58	6166.33	6971.67
B.Aus	8635.00	5868.00	0.00	281.66	614.97	6764.63	1870.37
HYV Aus	24282.00	8149.00	1705.00	472.99	1032.70	11359.69	12922.31
Jute	24704.00	7395.00	0.00	354.96	775.00	8524.96	16179.04
Pulse	11936.00	2665.00	0.00	127.92	279.29	3072.21	8863.79
Oilseed	8577.00	4465.00	0.00	214.32	467.93	5147.25	3429.75
Wheat	15512.00	6364.00	0.00	305.47	666.95	7336.42	8175.58
Potato	41790.00	14853.00	0.00	712.94	1556.59	17122.54	24667.46
Veg/Spices	66108.00	8828.00	0.00	423.74	925.17	10176.92	55931.08
Tobacco	22639.00	8448.00	0.00	405.50	885.35	9738.85	12900.15
Sugarcane	42380.00	15506.00	0.00	744.29	1625.03	17875.32	24504.68

N.B. Crop residues not excluded from jute since not used for fodder.

Source: NWRS Estimates

6.2.2 Benefits/Disbenefits for Fisheries

The analysis of fisheries impacts has also followed the approach used and described in the Regional Plan. Productivity rates for different habitat-types have been determined for future-without and future-with project conditions: these are shown in Table 6.6. Prices received by fishermen/pond owners have been used as financial prices; these have been increased in the economic analysis by 25% to account for future scarcity, particularly of capture fisheries species. The areas of floodplain fisheries are determined from the Gaibandha hydro-dynamic model and relevant productivity rates applied to these areas.

An impact analysis was undertaken to compare present condition, "future without" and "future with". The analysis is described in full in volume 12 Fisheries, of the Draft Final Report and summarised here. The results are displayed in Table 6.7 and show that doing nothing will result in a 15% loss of capture fish production from the present condition with no compensatory gain from fish farming. The project results in a 50% reduction in capture fish landings, but this is partly compensated by a 33% increase in farmed fish output. However, the net effect is that the project produces a greater overall loss (12%) compared to 8% in the "Do Nothing" case. In neither case was any allowance made for possible mitigatory action. However, a mitigation and fisheries development plan is described in Section 5.4.

Table 6.6 Fish Catch Rates (Kg/ha)

	Present Condition	Future Without	Future With (Full FCD)	Future With (Partial Protection)
Beels	400	400	250	400
Rivers	40	40	20	40
Floodplains	70	70	50	70
Ponds:				
Cultured/Cultura	850	850	1000	850
Derelict	180	180	50	50
Borrow Pits	180	180	250	250

Source: NWRS estimates

Table - 6.7 Impact of Structural Measures on Fisheries

		Area (ha)	Yield (kg/ha)	Production (mt)
1.	<u>Present</u>			
		200	400	80
	Beels (Perennial)	180	180	32
	Beels (Seasonal)	1800	40	72
	Rivers & Canals	3021	70	211
	Fishable Flood Plain	380	850	323
	Ponds C&C	90	180	16
	Ponds D.	30	180	5
	Borrow-pits etc.			
			Total	739
2.	<u>Future With</u>			
		180	250	45
	Beels (Perennial)	--	--	--
	Beels (Seasonal)	1700	20	34
	Rivers & Canals	2188	50	109
	Fishable Flood Plain	450	1000	450
	Ponds C&C	50	50	2
	Ponds D.	50	250	12
	Borrow-pits etc.			
			Total	652
3.	<u>Future Without</u>			
		200	350	70
	Beels (Perennial)	180	150	27
	Beels (Seasonal)	1800	35	63
	Rivers & Canals	3021	60	181
	Fishable Flood Plain	380	850	323
	Ponds C&C	90	150	13
	Ponds D.	30	150	4
	Borrow-pits etc.			
			Total	681

6.2.3 Benefits of Reduced Crop and Non-Crop Damage

The methodology for deriving crop and non-crop damage described in the Regional Plan Final Report and Volume 13 of the Draft Final Report has basically been used for the Gaibandha analysis. In addition to the basic damage avoidance benefits within the project area, there are further damage reduction benefits in the impacted area beyond the project area. These benefits can be attributed to two measures in particular: sealing of the TRE upstream, and closing off the Alai River with a regulator. Damage reduction within the project area is assumed to apply to all damage caused by events upto the 1:20 year return period.

In the impacted area, since this area is not specifically protected against 1:20 year floods by the project, damage reductions have been worked out by comparing with- and without-project inundation areas for 1:5 year and 1:20 year water levels: some of the impacted area with-project becomes protected against 1:5 year floods but not 1:20 year floods, therefore the damage reduction has been calculated as the difference between expected annual damage from floods upto 1:20 and expected annual damage from floods upto 1:5. A smaller part of the impacted area does become protected from all floods upto 1:20.

The total expected annual damage avoided through project works is considerable. The damage estimates are shown in Table 6.8

Table 6.8 Estimated Average Annual Value of Damage in Project and Impacted Area

	(Tk. mm) 1991-1992 Financial Prices	
	Crop Damage	Non-Crop Damage
TRE Planning Unit	9.69	10.17
TRE Impacted Area	2.75	2.89
Ghagot Right Bank	3.9	4.1
Alai Right Bank	8.92	9.38
Sonail Embankment	0.79	0.83
Gaibandha Project Area	16.3	17.12
Gaibandha Town	-	0.5
Total:	42.35	44.99

Source: Consultant's Estimates

6.2.4 Erosion Losses

Benefits from avoidance of erosion losses on the Teesta River are highly significant in terms of the project concept and its justification. The Teesta River is moving south-west into the project area at a rate causing estimated erosion losses of 180 hectares per year in downstream reaches, and 60 hectares per year in upstream reaches. If this erosion continued, large amounts of agricultural land would be lost, infrastructure and property would be washed away, Sundarganj thana headquarters would be likely to be washed away, and considerable dislocation of hundreds or thousands of households would occur.

The technological choice between river training and embankment retirement was analysed and discussed in Section 4.4. The justification for river training is largely to avoid the losses listed above, as well as to reduce the possibility of long-term morphological change. Conversely, if embankment retirement is carried out, it would imply accepting the high erosion losses that presently exist.

The benefits in this category have, therefore, been considered in three locations:

- erosion losses in the Teesta upstream reaches, 60 ha. per year
- erosion losses in the Teesta downstream reaches, 180 ha. per year
- loss of property and infrastructure at Sundarganj.

The valuation of lost land is in terms of production foregone (net returns per hectare based on without-project cropping patterns are taken as the basis for the analysis.). The valuation of loss of property and infrastructure at Sundarganj is based largely on costs developed by the FAP 1 study which examined similar dangers at six locations on the BRE. These costs are shown in Table 6.9.

Table 6.9 Assumed Erosion Losses at Sundarganj

	No	Financial Unit Cost (Tk.mm)	Total Cost (Tk.mm)	Conversion Factor	Total Economic Cost (Tk.mm)
A. Property Losses					
Pucca Public buildings	10	2	20	0.85	17
Semi Pucca Public Buildings	20	0.2	4	0.80	3.2
Pucca House and Shops	10	0.25	2.5	0.85	2.13
Semi Pucca House and Shops	950	0.01	9.5	0.80	7.6
Katcha Houses and Shops	950	0.003	2.9	0.67	1.95
Village Houses	5000	0.001	5	0.67	3.55
B. Infrastructure Losses					
Roads: - Semi Pucca	3	1	3	0.85	2.55
- Katcha	9	3.2	3.2	0.66	2.11
- Bridges/Culverts	5	0.2	1	0.89	0.89
				Total	40.78

Source : Consultant's Estimates
Unit rates adapted from FAP1 Second Interim Report, December, 1991.

6.3 Cost Assessment

The basis of project costing is detailed in Volume 6, Engineering, of the Draft Final Report. A summary of project costs and phasing of expenditure are given in Tables 5.1 and 5.3 of this report.

Construction Costs

The method for deriving economic capital costs follows that used and described in the Regional Plan Final Report with different allowances being made for the more detailed level of study. Two alternative methods of construction were considered: results of the comparison of these alternatives are discussed in Section 4.4. For the basic analysis, it was assumed that the manual construction method would be used. The latter is 30% cheaper than the method using more mechanised means and provides significant employment in an area of considerable underemployment and poverty.

The phasing of economic capital costs follows the implementation schedule.

O&M Costs

The method for deriving economic O & M costs again follows that used for the Regional Plan. Annual O & M costs are calculated as 5% of capital costs in the case of earthworks, and 3% in the case of structures. Sensitivity analyses have also been conducted assuming higher O & M costs, of

10%, for bank protection works on the Teesta Rivers. Results of these (and other) sensitivity analyses are discussed in section 6.4.2.

Economic Costs of Land Acquisition

The economic cost of land acquisition is calculated as the net value (in economic prices) of production foregone from the acquired land, using the without-project cropping pattern to derive net value. These land acquisition costs enter the cash flow according to the implementation schedule as land is acquired for different components of the overall work.

Costs of Embankment Retirement on the Brahmaputra River

Measures along the BRE fall within the plan being prepared by FAP1. The Brahmaputra is relatively stable along the Gaibandha reach and there are therefore no plans to undertake major bank protection works. There will, however, be a need for some embankment retirement.

The cost of embankment retirement is included as a project cost : it is assumed to take place on an annual basis over the whole project period along a 25 km stretch, i.e. an average length of about 0.83 km per year.

The associated loss of land left outside the retired stretch is not counted as a project disbenefit, however, since it would be lost under both with and without conditions.

6.4 Results of Economic Analysis

6.4.1 Base Analysis

Each of the components of the project described in Section 5.1 have impacts which, as far as possible, have been measured and valued.

The main areas of benefit/disbenefit are:

- General reduction in water levels primarily due to upstream sealing of the Teesta.
- Further reduction in water levels and prevention of damage due to extension of embankments on the Ghagot River.
- Reduction of flows down the Alai River causing a reduction in water levels and damage downstream of Gaibandha.
- Prevention of losses due to erosion by the Teesta River, particularly in the downstream reaches around Sundarganj.
- Alterations in drainage patterns to reduce the amount of water draining across the whole area.
- Reductions in water levels and damages in the impacted area.

Most of the measures result in some reduction in water levels. This reduction has some impact in terms of increasing crop production, but the impact is not very great since most of the area is already planted to t. aman and in the areas of deepest flooding the backwater influence of the Brahmaputra prevents any major change in flood depths. Significant reductions in damage should however be achieved as a result of the project. This is important since Gaibandha is the worst affected district in the Greater Rangpur District in terms of crop damage, and by association also suffers considerable damage to infrastructure and property.

One of the greatest positive impacts of the project will be in terms of reducing erosion losses. Current rates of erosion by the Teesta River on its right bank vary, but it has been assumed that in the upstream area 60 hectares of land would be lost every year, and in the downstream reaches 180 hectares. In the downstream reaches the Sundarganj thana headquarters is also threatened by erosion. Not only will river training prevent these losses, but it should also aim to make the river more stable and reduce the morphological risks associated with the current processes.

The reduction in water levels will have a negative impact on capture fisheries, but the overall impact appears to be rather small. This is partly a reflection of the relatively small area of effective floodplain, and also of the gradual reclamation of what were previously quite widespread beel areas. Specific mitigation and development measures are proposed for the fisheries sector in Chapter 5.

Construction costs are high, but this is unavoidable given the need for river training works. The high cost measures on the Teesta River nevertheless have a wide impact, particularly the upstream sealing. Although this work lies outside the project area, it has a major impact on the area and was therefore included in the project. Since upstream sealing also affects a wider area, the impact felt in this area in terms of reduced crop and non-crop damage was also included in the benefits.

The IRR for the base case is 10%. The cash flow analysis is shown in Table 6.10. The IRR implies that the project is marginal from an economic viewpoint, although it will have considerable employment benefits and greatly reduce flood risks over a large area. The main reasons for the low IRR are the high costs of river training works and the relatively small cropping changes that are predicted to take place.

6.4.2 Sensitivity Analyses

A number of sensitivity analyses were carried out on the base case. Results are reported and discussed here.

Import Parity Pricing for Rice

The economic price assumed for paddy crops in the basic analyses has been based on the mean of the import and export parity price, i.e. it implies a position of approximate self-sufficiency in rice output. While this appears to be the position at present, it is not yet clear whether the output increases of the past can be maintained. If Bangladesh again reverted to a position where import parity pricing was appropriate, the economic price assumed for paddy would increase.

TABLE 6.10 GAIBANDHA IMPROVEMENT PROJECT, ECONOMIC ANALYSIS: BASE CASE PATTERNS

(Tk mn, 1991-92 prices)

Year	Cap. Cost	O&M Cost	Total Cost	Net Ag. Returns w/o Pro	Net Prod. Lost	Crop Loss Avoid.	Sund-ergonj Loss Avoid.	Net Ag. Returns w.Pro.	Red. Crop Damage	Ag. Benefits w.Pro.	Net Fish Return w/oPro	Net Fish Return w.Pro	Fish Bene-fits w.Pro	Red.Non-Crop Dam.	Total Net Benefit	Net Cash Flow	Disc. Factor (12%)	Present Value of Benefits	Total Public Cost	PV of Public Costs
0																				
1	51.88	0.00	51.88	1217.87	0.08	0.00	0.00	1217.87	0.00	-0.08	25.15	25.15	0.00	0.00	-0.08	-51.96	0.89	-46.40	327.91	292.82
2	51.88	0.00	51.88	1217.87	1.50	0.00	0.00	1217.87	0.00	-1.50	25.15	25.15	0.00	0.00	-1.50	-53.38	0.80	-42.54	497.51	396.52
3	164.19	0.00	164.19	1217.87	3.59	0.00	0.00	1217.87	0.00	-3.59	25.15	25.15	0.00	0.00	-3.59	-167.78	0.71	-119.46	998.94	711.25
4	297.76	0.00	297.76	1217.87	6.40	0.00	4.10	1217.87	0.00	-2.30	25.15	25.15	0.00	0.00	-2.30	-300.06	0.64	-190.84	1263.37	803.50
5	346.78	31.34	378.12	1217.87	8.91	5.04	4.10	1231.94	25.85	40.15	25.15	25.39	0.24	27.34	67.73	-310.39	0.57	-175.99	1400.62	794.15
6	179.82	31.34	211.16	1217.87	10.07	10.08	4.10	1246.01	25.85	58.10	25.15	25.39	0.24	28.16	86.50	-124.66	0.51	-63.20	1066.17	540.55
7	74.69	39.10	113.79	1217.87	10.87	15.12	4.10	1260.08	34.39	84.95	25.15	25.39	0.24	37.89	123.08	9.29	0.45	4.20	718.30	324.67
8	31.59	45.64	77.23	1217.87	11.37	20.16	4.10	1274.15	34.39	103.56	25.15	25.39	0.24	39.02	142.82	65.59	0.40	26.50	604.83	244.35
9	18.25	45.64	63.89	1217.87	12.20	25.20	4.10	1288.22	34.39	121.84	25.15	25.39	0.24	40.19	162.27	98.38	0.36	35.52	606.42	218.92
10	25.42	47.24	72.66	1217.87	13.02	30.24	4.10	1288.22	34.39	126.06	25.15	25.39	0.24	41.40	167.70	95.04	0.32	30.60	687.97	221.53
11	14.31	47.24	61.55	1217.87	13.31	35.28	4.10	1294.08	37.26	139.54	25.15	25.39	0.24	45.62	185.40	123.85	0.29	35.54	417.33	119.77
12	4.66	47.24	51.90	1217.87	13.39	40.32	4.10	1299.94	37.26	150.36	25.15	25.39	0.24	46.99	197.59	145.69	0.26	37.44	46.91	12.06
13	4.66	47.24	51.90	1217.87	13.47	45.36	4.10	1305.81	37.26	161.19	25.15	25.39	0.24	48.40	209.83	157.93	0.23	36.17	46.91	10.74
14	4.66	47.24	51.90	1217.87	13.55	50.40	0.00	1305.81	37.26	162.05	25.15	25.39	0.24	49.85	212.14	160.24	0.21	32.85	46.91	9.62
15	4.66	47.24	51.90	1217.87	13.63	55.44	0.00	1305.81	37.26	167.01	25.15	25.39	0.24	51.35	218.60	166.70	0.18	30.51	46.91	8.58
16	4.66	47.24	51.90	1217.87	13.71	60.48	0.00	1305.81	37.26	171.97	25.15	25.39	0.24	52.89	225.10	173.20	0.16	28.23	46.91	7.65
17	4.66	47.24	51.90	1217.87	13.79	65.52	0.00	1305.81	37.26	176.93	25.15	25.39	0.24	54.47	231.64	179.74	0.15	26.24	46.91	6.85
18	4.66	47.24	51.90	1217.87	13.87	70.56	0.00	1305.81	37.26	181.89	25.15	25.39	0.24	56.11	238.24	186.34	0.13	24.22	46.91	6.10
19	4.66	47.24	51.90	1217.87	13.95	75.60	0.00	1305.81	37.26	186.85	25.15	25.39	0.24	57.79	244.88	192.98	0.12	22.39	46.91	5.44
20	4.66	47.24	51.90	1217.87	14.03	80.64	0.00	1305.81	37.26	191.81	25.15	25.39	0.24	59.52	251.57	199.67	0.10	20.77	46.91	4.88
21	4.66	47.24	51.90	1217.87	14.11	85.68	0.00	1305.81	37.26	196.77	25.15	25.39	0.24	61.31	258.32	206.42	0.09	19.20	46.91	4.36
22	4.66	47.24	51.90	1217.87	14.19	90.72	0.00	1305.81	37.26	201.73	25.15	25.39	0.24	63.15	265.12	213.22	0.08	17.70	46.91	3.89
23	4.66	47.24	51.90	1217.87	14.27	95.76	0.00	1305.81	37.26	206.69	25.15	25.39	0.24	65.04	271.97	220.07	0.07	16.29	46.91	3.47
24	4.66	47.24	51.90	1217.87	14.35	100.80	0.00	1305.81	37.26	211.65	25.15	25.39	0.24	66.99	278.88	226.98	0.07	14.98	46.91	3.10
25	4.66	47.24	51.90	1217.87	14.43	105.84	0.00	1305.81	37.26	216.61	25.15	25.39	0.24	69.00	285.85	233.95	0.06	13.80	46.91	2.77
26	4.66	47.24	51.90	1217.87	14.51	110.88	0.00	1305.81	37.26	221.57	25.15	25.39	0.24	71.07	292.88	240.98	0.05	12.77	46.91	2.49
27	4.66	47.24	51.90	1217.87	14.59	115.92	0.00	1305.81	37.26	226.53	25.15	25.39	0.24	73.21	299.98	248.08	0.05	11.66	46.91	2.20
28	4.66	47.24	51.90	1217.87	14.67	120.96	0.00	1305.81	37.26	231.49	25.15	25.39	0.24	75.40	307.13	255.23	0.04	10.72	46.91	1.97
29	4.66	47.24	51.90	1217.87	14.75	126.00	0.00	1305.81	37.26	236.45	25.15	25.39	0.24	77.66	314.35	262.45	0.04	9.71	46.91	1.74
30	4.66	47.24	51.90	1217.87	14.83	131.04	0.00	1305.81	37.26	241.41	25.15	25.39	0.24	79.99	321.64	269.74	0.03	8.90	46.91	1.55
TOTAL																	NPV=	-111.54		4767.48
																	IRR=	0.10		
																	NPVR=	-0.02		

The FAP Guidelines for Project Assessment calculate a conversion factor of 1.02 for paddy for import parity pricing. This study estimates the appropriate conversion factor to be 1.19 (see discussion in Volume 13, Economics, of the Draft Final Report). Sensitivity analyses have been done for both conversion factors:

	Conversion Factor	Conversion Factor
	1.19	1.02
IRR	12.7%	11.3%

The analysis with a conversion factor of 1.19 increases the IRR to just above 12%.

10% Increase in With-project Agricultural Net Returns

A 10% increase in the value of with-project agricultural net returns increases the IRR to about 17%. This indicates the relative sensitivity of this project, and others analysed for the Regional Plan, to changes in agricultural returns.

20% Increase in Construction and O&M Costs

This increase in costs causes the IRR to fall to about 8%. Since the cost estimates are based on rates well above existing rates, and the implementation period is long, there are no particular reasons for such cost overruns to occur.

O&M Rate of 10% for River Training Works

Since the cost of river training works is estimated at almost Tk. 600 mn, an increase in the O&M allowance for such works has a significant impact: an increase to 10% reduces the IRR to 6%.

Lower Rate for Labour

The cost estimates have been based on Tk 55 per day for unskilled labour. These estimates conventionally include a percentage for contractors' profit. Contractors normally pay labour at most at the current market wage rate, taking the difference as profit. However, since the market wage rate in Gaibandha is very low (Tk 20-30), and since, if LCS groups are employed, the contractors' profit would be reduced, actual cost savings could be made. If the costs were based on a rate for unskilled labour of Tk 40 instead of Tk 55, the IRR would increase to 11%.

Hazard Analysis

This sensitivity run explores a hypothetical extreme event causing embankment failure. It assumes failure shortly after completion of all parts of the project. Resulting damages are assumed roughly equivalent to actual damages during the 1988 flood, and are followed by a need for reconstruction (assumed at 50% of original construction costs), and a period of 4 years during which recovery back to full development takes place. The IRR under this scenario drops to 3.3%. Although the analysis is speculative, it serves to demonstrate the risks associated with failure of the structural elements of the project. The damages in such an extreme event would be similar without the proposed developments.

Analysis of Individual Project Components

Further analyses were conducted to attempt to identify the benefits generated by individual components of the project. The analysis is not precise since it is not always possible to separate out the benefits: however the analysis is broadly indicative of the significance of each component.

The base case, including all components, has an IRR of 10%. This includes provision for backwater embankments on the Ghagot river and a new regulator on the Manas river, to provide protection in the likely event of the current Manas regulator being washed away.

However, since these works will essentially fulfil the same function as the existing regulator, they produce no benefits over the present situation with the Manas regulator still in place. It could in fact be argued that the future-without condition should exclude the Manas regulator. Although the latter analysis has not been conducted, an analysis has been carried out of the base case excluding these replacement costs. The IRR increases to 12% in this case.

Other analyses were conducted of individual project components: these analyses included the replacement cost of the Manas regulator.

The sealing of the Teesta Right Embankment and construction of a regulator on the Alai river were analysed together, since it is difficult to desegregate agricultural benefits in the Alai basin. The IRR in this case is 11% (If Manas regulator replacement costs are excluded from this analysis, the IRR increases to 13%).

It is reasonable to conclude from the above analysis that sealing the Teesta Right embankment, probably in conjunction with regulation of the Alai river, is the priority work and is on the margin of economic viability. This justifies the proposed phasing of the overall project, since more study will be required to establish the precise design of compartmentalisation which in a preliminary analysis does not render significant additional economic benefits.

CHAPTER 7

IMPACT ASSESSMENT

7.1 Environmental Impacts

7.1.1 Component Impacts

Sealing the BRE and TRE

The significant reduction in flood damage due to breaches will be offset to some extent by disbenefits in the loss of fish and wetland benefits. Many of these effects had already occurred in the initial construction period. Some of the losses are thus not directly attributable to this phase of investment. The GIP strategy will rectify some of these earlier losses through the planned removal of the Manas Regulator (see c. below).

Removal of the Existing Manas Regulator

All the rounds of public participation and the hydraulic modelling indicate that the removal of this structure will alleviate the disbenefits of impeded drainage it currently causes. In practise, erosion is likely to remove it anyway. There were no grounds established where its future role could be justified. As the structure could pose a physical hazard it would be advisable to plan for its organised demolition and removal.

Its removal will revitalise the system again. The benefits will include - the unrestricted passage of fish migration; the unrestricted flushing of pollutants away from Gaibandha town which either originate there or from Rangpur; unrestricted seasonal navigation to and from the Jamuna and Ghagot systems which will benefit inter-regional, intra-regional and local commercial, marketing and domestic boating networks.

Minimising External Impacts

A fundamental principle applied throughout the NWRS is the avoidance of schemes that make people worse off downstream or in adjacent areas. The confinement of the Ghagot on the left bank, the need to rationalise the flood protection levels in the backwater areas of the Jamuna (once the existing Manas regulator has been removed), and the need to avoid river capture of the Jamuna down the Alai, all require that a regulating structure be sited at the head of the Alai. This effectively is an in-built mitigation component, as well as part of a regional strategy to alleviate flooding in the Alai floodplain by diverting some drainage flows to the Jamuna through the Ghagot.

Options to embank the right bank of the Ghagot were examined to avoid spillage to the right bank floodplains and beels. The model results showed that once the TRE has been effectively sealed the effects of the GIP schemes on the Ghagot river levels are minimal and would not require any mitigation by embanking the right bank. Flood protection measures required for the Ghagot right bank areas thus remain a study in their own right.

Construction of a New Regulator at the Confluence of the Manas and Ghagot and Completion of the BRE

This component showed no positive hydraulic or economic effects during the early analysis within events less than the design criteria laid down under FAP for an agricultural area (1:20 year flood protection). The analysis showed that, in most years, the location of this regulator would actually impede drainage in the same way that the existing Manas regulator does. As a physical obstruction it will also have many basic disbenefits affecting both biological, water quality and navigation systems into the Manas basin. On pure technical and economic grounds there was no justification for this additional investment cost.

It has been argued that some local people within the GIP area might be unhappy to see the existing Manas Regulator removed and then the GIP system left totally open to the potential of flooding from the Brahmaputra. However, the risks of flooding from the Jamuna into the GIP area appear infrequent and not catastrophic (unless the BRE is breached). There has been no public consultations to elicit the community's actual response to this proposal.

The regulator might also be necessary to rationalise the boundary disparities in flood protection in the backwater area influence of the major rivers that have 1:100 year flood protection along their main river frontage. The flood heights associated with the 1:100 year flood event near to the design criteria of the BRE would flood areas within the Manas basin. The degree of damage that this flooding would result in is probably far less than the damage from a similar event in the Teesta. Breaches in, or overtopping of the TRE, would create considerable damage to parts of the GIP. In this event the Manas regulator may again be an impediment, rather than an aid to flood relief.

The issue of the degree of protection to be given along the extension of the BRE on both sides of the confluence of the Ghagot and Jamuna is a policy decision based on the switch in boundary conditions required by opening the Jamuna to the Ghagot and its 1:100 year protection level and that of 1:20 year protection for the GIP on its southern side.

Extending the Ghagot Left Embankment (GLE)

The inclusion of this component has been justified partially on the grounds that it logically forms a part of a complete package of engineering structures to control water that is consistent with traditional FCD interventions. Basic flood protection to the area behind this embankment primarily is achieved through the sealing of the TRE. The beneficial effects of the GLE would be to provide flood protection to a part of the GIP area. It again has hidden sunk costs as it will mainly rehabilitate existing roads. The inclusion of these sunk costs would reduce the basic economic benefits in any similar component that had to start from scratch. The construction works, nonetheless, are cheap and will create local employment. The connection of the spills to the important major water body of Bamandanga beel has been built into this embankment alignment. However, this remaining alignment may still leave other beels and floodplain areas isolated.

Compartmentalisation

The results of the modelling and economic analysis show significant hydraulic benefits accruing to the sub-division of the area into drainage compartments. The context must be understood. First, the strategy is based on using existing roads which become sunk costs in the analysis. Second, the scale at which each compartment is being modelled has reached the boundary limits for proper analysis.

Thus, the actual conditions and distribution of water within compartments cannot be well understood or modelled. This is because of the local variation in micro-topography and the degree of landscape alteration already undertaken by local communities. Thus, cumulative impacts of many small areas, where impeded drainage or more drought prone areas may occur, is currently undefinable. The benefits or disbenefits of this, according to the social structure and socio-economic and political organisation within each compartment, are also unclear.

7.1.2 Impacts in the Pre-Construction Phase

The current study has introduced the first level of impacts into the area, particularly through its association with a major national project FAP that is already a subject of public debate in the media. The levels of public participation have also made the potential future investments well-known to the local communities. Their effects of this cannot be ascertained at the current time, but may include impacts on land values and local tactics to dispose of or acquire land in a speculative fashion in advance of these works actually beginning.

7.1.3 Impacts in the Construction Phase

By far the most important benefit to be derived from construction will be the potential for generating local employment and Food-for-Work options. This programme can bring temporary relief to the condition of many economically and resource poor people.

The most significant adverse effect will be the need for land and the displacement of people. The socio-economic profiles show intense deprivation already existing. Dispossession can transform access to survival strategy and future opportunities. The resettlement options are negligible. The scheme will have to rely on a sympathetic and well-managed compensation programme. The land acquisition problems of FAP have been the responsibility of FAP 15. They concluded that major changes are needed to ensure speedier and more equitable settlement of claims. Without this they are likely to be a major constraint to the implementation of project requiring land acquisition under the FAP. Their conclusions and recommendations must be made integral to the TOR, staffing and work capabilities of the detailed design stage. The phasing of these studies must also be carefully matched to the time by when the land acquisition process must be completed to allow actual construction to begin.

The drain on non-renewable and scarce resources of the construction phase of GIP has not been carried out in detail for each major item. As an indicator of scale the number of bricks required has been estimated. This will be a drain on national energy resources in the form of fuelwood, coal or gas. The results indicate a consumption of 900 cu.m.of bricks for all works. This would require in the order of 250 tonnes of fuelwood. Disposal of spoil is not regarded as a major issue for further compensation payments.

A number of important sites of cultural and historic significance lie very close site of construction works. Further survey and assessment of the specific mitigation will be required in the detailed design phase.

7.1.4 Impacts in the Post-Construction Phase

Physical Impacts

The critical impact of the physical and dynamic effects of river morphology and erosion as a basic risk must be emphasised. These are effects that will express themselves in the short to medium term future. Internally the processes affecting siltation of drainage channels and soil quality will not be significant. A major benefit will be the prevention of poor quality soil covering farmers' fields when washed through major breaches.

If major river training works proposed prove deficient to impede the movement of the Teesta or the Brahmaputra there will be a need for ongoing retirement of the embankments.

Biological Impacts

Internationally, nationally or regionally the GIP area is not significant for the habitats or species diversity it supports. No requirements for protected areas is necessary.

The key problems noted for the area include the role of medicinal plants, the encouragement of food diversity and community based programmes to ensure that habitats suitable for the spread of malaria are minimised.

The bacterial quality of many surface water supplies is unsatisfactory, and is a major cause of diarrhoeal disease outbreaks. Without adequate sanitation development, this situation cannot be expected to improve. No significant levels of any common toxins were detected in the study surveys, but they are reported to be locally significant near industrial units in Gaibandha and Rangpur. The chemical standards set for drinking water are in some cases irrelevant and would preclude every tubewell source tested, despite their being generally the best quality water available in the Region. The proposed interventions are unlikely to have any significant effect on surface water oxygenation, since reducing flows permits the development of phytoplankton, which form an alternative source of supply for aquatic organisms.

High soil water levels in the highlands may inhibit the ability of many trees to absorb nutrients, a process promoted by the fungae-tree association. Interventions which reduce the water table in highland areas, therefore, have the potential to improve the nutrition of trees, which provide the most important ranges of natural resources for rural people. Flood interventions potentially affect soil biology by altering the balance between processes which alternate through the annual inundation cycle. The present semi-natural system relies considerably on aquatic components. Interventions, which cause an increase in the length of time that the soils remain unsaturated each year, will certainly cause a reduction in nitrogen fixation. This nitrogen is another of the "free goods" of the floodplain, which will need to be replaced by traded goods if the natural cycle is disturbed.

The proposed interventions may potentially encourage the preservation of the floral and animal diversity in the highlands by reducing a high watertable in the flood season. This will enhance the growth of the trees which form the dominant group in the highland habitats, and so improve the resource availability of those species which rely on them.

The embankments serve as important linear habitats and are major dispersal corridors for many species, some of which may be reservoirs of infectious diseases which affect humans. They are also important as dispersal routes for the agents of some contagious human and animal diseases. They provide shelter - often the only shelter - amongst the open and generally treeless fields of the floodland for the wild birds which feed on insects which may at times become crop pests.

The importance of the beels does not lie in their conventional role as wetland reserves for wildfowl, but as dry-season refuges for the floodland fish. The preservation of the fish stocks, which should be a matter of international concern, demands that the present network of beels and river channels should be maintained and the fish sheltering in them protected by sound and effective management policies, to ensure that their access to their essential energy source, the floodland, is continued. This means that compartmentalisation centred on the major beel complexes, but allowing some access to the river channels as well, is the correct approach to the management of the fish stocks in the area.

7.1.5 Cumulative Impacts

There are a range of cumulative impacts which may affect the basic integrity of the project. These relate to risks and hazards of extreme events that would exceed the design criteria of the scheme. The GIP would be at risk because of its location at the confluence of two large rivers.

Cumulative impacts associated with the trends in current farming systems will result in the longer term in the complete loss of sound environmental management. Remedial strategies based on integrated pest management (IPM) and integrated resource management are recommended.

7.1.6 Residual Impacts

Increased Damage and Disruption

The most significant residual impacts will include the higher risks of damage and disruption of failure to maintain the integrity of the sealing of the BRE and TRE. As each year goes with the embankments complete the attitude to risk inside the GIP will change, affecting land and other values in the society and the natural resource base concerned. Growth of small villages into towns and small towns into cities would accompany the growth in population and greater levels of infrastructure and commercial investment in other sectors if this were commercially attractive. Any failure after many years of no breach would lead to increasing levels of damage and disruption. This appraisal stresses the need for a properly integrated flood proofing and disaster preparedness programme to be totally integrated into the detailed design phase.

Impeded Drainage

The cutting of even small local drainage lines will create varying degrees of recurring impeded drainage across the compartments. These areas will require special attention and management to ensure that problems of poor water quality and development of sites for insect vector breeding do not develop. These aspects can probably be mitigated to some extent during the detailed design phase and by monitoring of the system after construction to identify appropriate levels of response in the agricultural, fisheries and public health sectors.

Reduced Floodplain Processes

The upstream potential sources of pollutants from outside the project into the GIP area come mainly from Rangpur. The diversion of flows into the Ghagot and off the GIP floodplain will be of marginal benefit to GIP and will tend to raise the pollutant load of the Ghagot.The most significant feature here will be the lack of flushing and dilution after sealing the TRE. The capacity of floodplain wetlands to take up nutrients and pollutants would be reduced by disconnecting them from the Ghagot and heavier reliance would be put on the capacity of the river Ghagot bio-system to undertake this role. This residual impact would require monitoring and, if necessary, lead to controls and processing of potential pollutants and sewage from sources which currently primarily emanate from Rangpur.

The loss of connections to many floodplain depressions and beels will affect the characteristics of the habitat and species composition of wetland dependant species. However, the results of compartmentalisation indicate that some wetland areas may be advantaged, while other may be disadvantaged. The basic change in the system is that recharge will come more from local rainfall catchments and not from spillage out of connections to the Teesta waters and its aquatic life forms that are transmitted in the current system. Given that the current degradation of the ecology from its natural state is so extensive, this issue can no longer be of primary concern.

Losses to floodplain fisheries are forecast with the project in its current format. This will significantly change the current system of exploitation and survival strategies that utilise this natural resource base. These impacts are most likely to affect those who are already the most disadvantaged including the poor, landless, women and children. The effects would need to be monitored and responded to in other forms of relief efforts. The key areas for monitoring will be access to income-generating activities and deteriorating health status, often associated with nutrition-related disorders.

7.2 Social and Economic Impacts

The sealing of the TRE would have a positive impact on nearly all the communities in the GIP as evinced by the findings of all the fieldwork carried out. The main negative impact would be if sufficient care were not taken to allow fish migration from the river into the beels and khals of the northern part of the project area. Rural appraisals in the northern part of the project area revealed that communities want the embankment sealed properly but they also want gates in the main embankment from which they can let water into and out of the area as required by flood, agricultural or fishing considerations. These gates would allow fish migration but require human management which opens and closes them at the appropriate times.

Likewise effective sealing of the BRE will have positive impacts on most of the GIP area providing water which gathers inside the embankment can be released into the Brahmaputra. The major contemporary problem is the Manas regulator which is slowly being destroyed by Brahmaputra bank erosion. It is generally the opinion of most communities in the GIP area, and indeed many to the south of it, that it never achieved its potential in relieving flooding inside the project area. These complaints come from nearly every thana in the GIP area apart from a few communities living close to it.

The removal of the Manas regulator has the positive impact of allowing free migration of fish to and from the Brahmaputra and an improvement to the deteriorating river transport system that has been a feature of the area over the last decade. In the public participation sessions which were held in the area this option of opening of the internal drainage system to the Brahmaputra was warmly welcomed in nearly all of the thanas where meetings were held.

The option for the Ghagot and Manas also allows for a regulator where the Ghagot enters the Alai. This aspect of the GIP option will have positive social impacts outside the GIP area. It will mean that flood water which previously flowed down the Alai can be directed into the Brahmaputra by closing the gate on the Alai. Those communities on its right bank which have continuously cut the Sonail Embankment will be given a better degree of protection than at any time since the Sonail project was conceived. With this gate and developments to the south of the Sonail Embankment it is highly probable the cuts made by the public in the embankment will be avoided.

Another area which is not in the GIP but which will have positive impacts as a result of the above options comprises the communities on the right bank of the Ghagot and to the east of the main Gaibandha to Sadullapur road. These communities presently suffer from heavy siltation in the Ghagot, much of which they claim comes from the Teesta. They also suffer because the embankment on the left bank of the Ghagot acts as a drainage barrier when they are inundated by a combination of heavy rain and spillage from the Ghagot. The project works should help to reduce these problems.

A significant social impact will be the increased employment generated from both construction works, raised agricultural production and the more equitable distribution of the flood waters that will remain after the reductions attained through sealing the main river embankments.

Social tension may arise through conflicts over water, particularly between fishermen and farmers. This stresses the need for a full mitigation programme for fisheries and for the development an operational framework where paddy-fish culture is promoted amongst predominately farming communities. Resource tenure and the degree of community participation in organising the details of local water management systems will be the key to reducing these conflicts and enhancing the benefits which could come through the potential complementary features of multi-purpose farming systems.

The public health and nutrition status in the area is particularly poor. The resurgence of malaria internationally, the risks associated with the development of the irrigation canal schemes along the Teesta, and the likely problems of impeded drainage that will result at the micro-level within the scheme all indicate that the highest priority be put on mitigating these potential problems. Properly staffed and adequately resourced specialist teams should be sent to the area to carry out in-depth surveys to assess the current situation and potential for risks based on the project plans as developed to date. These same specialists should also be directly attached to the detailed design phase to issue the minimum criteria for the engineering and operational designs.

A number of important local sites of cultural and historic interest lie close to sites of construction. Local and specialist advice must be gained, preferably before the detailed planning phase begins, on how these sites should be treated.

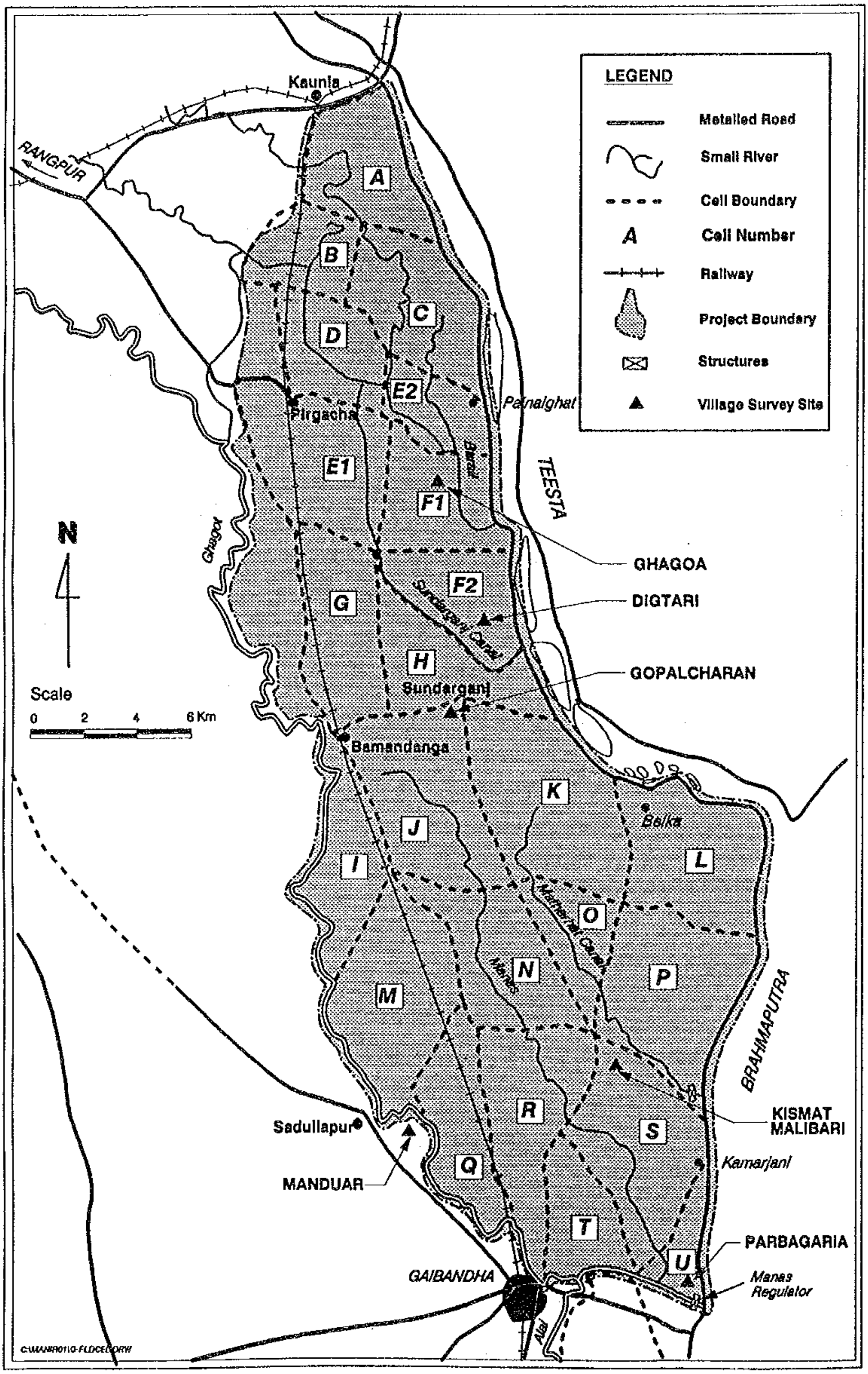
7.3 Farm-Level Changes in Cropping and Income Distribution.

An agro-economic survey was conducted in the project area, comprising six villages and 210 farm households. The villages were chosen to represent different conditions in relation to present-condition flooding and potential impact of the project (Figure 7.1).

A complete household census was taken in each village, and households were then stratified according to land ownership. A total sample size of 35 households was selected from each village, and households were sampled from each farm-size group approximately proportional to their total number in the village. However, at least 5 pure tenant households and 5 large farmer households were also selected in each village.

Figure 7.1

Location of Agro-Economic Survey Villages



The survey results for the six villages have been analysed to determine changes in cropping patterns and income as a result of project interventions. The results are discussed on a village basis below, but first the basic methodology is explained.

The methodology for analysing farm-level cropping changes follows the approach used to analyse aggregate cropping changes for the economic analysis, as described in section 6.2.1. Present-condition cropping patterns were derived directly from the farm survey on a farm-size basis. Farmers were asked to classify their land in terms of high, medium-high, medium-low and low land (corresponding with F0, F1, F2 and F3 land) and the crops as reported in the survey were then allocated to particular land levels.

Future-without cropping patterns were then derived on the basis of the projected growth of irrigation in the project area. The assumption used in the economic analysis was that irrigation would grow from 29% coverage to 48% based on analysis of irrigation equipment statistics and groundwater availability (see volume 10 of the Draft Final Report). In some of the villages even this upper limit is already exceeded, and therefore a similar proportionate rate of growth was assumed from the base as revealed in the survey. An upper limit of 80% was imposed however (the only exception being on sharecropped land, since many sharecroppers grow HYV boro as the main crop and therefore must have access to irrigation).

The change in irrigation coverage was the only change assumed between present and future-without conditions.

Future-with cropping patterns are the result of the project interventions. As described in the Draft Final Report (Volume 9), the analysis of changes in flood levels is currently carried out at a rather aggregated level and it is not possible to accurately forecast changes at village level. Nonetheless, the hydro-dynamic model developed by NWRS for the Gaibandha project area is sub-divided into 23 sub-units (i.e. on average about 2,500 ha. per cell), for each of which a with- and without-project flood phase distribution has been derived. This is the best guide available to give an indicative analysis of the extent and direction of change.

Therefore, in deriving future-with project flood phase distributions for each village, the distribution given by the model for the sub-unit containing the specific village was used, at least as a guide. It could not be used exactly because the flood phase distribution reported by the sample farmers in some cases differed markedly from the sub-unit distribution, but the direction and approximate magnitude of change were derived from the model.

It is clear, too, that the approach as described above could be carried further in detailed design work, with agricultural and other surveys more closely tied in to a disaggregated model.

Once the future-with project flood phase distribution was established, changes in cropping patterns could be forecast.

The output of this analysis is, therefore, cropping patterns by farm size group and flood phase for present, future-without and future-with conditions. These cropping patterns are then the basis for the forecast of changes in net income due to the project.

The data on yields, prices and input use derived from the survey were used to calculate gross and net incomes on a per acre and per household basis. Some differences exist between farm size groups in input intensity, yields, and proportions of supplied to purchased inputs, and therefore the input-output data used to derive incomes were specific to the farm size group. Only prices were the same for all farmers.

The resulting analysis gives gross and net incomes by farm size group for present, future-without and future-with project conditions in each village. These data sets were initially derived for representative farm households, and then the village-level income distribution was derived simply by multiplying household incomes by the number of farmers of that group in the village.

Tables showing changes in flood phase distribution and resultant impact on farm incomes for each village are given in Appendix I and the results are described below.

A. Digtari.

Digtari is a village in Pirgacha thana in the north of the project area with a high proportion of low-lying land. It falls in an area where the effect of compartmentalisation may actually be to increase water levels compared with present conditions. The with-project conditions in this village are therefore forecast to stay the same or even to get marginally worse.

The flood phase distribution for the village is shown in Table I.1. This shows a small increase in flooding conditions. Table I.2 shows the impact on farm incomes. Incomes are unchanged between future-without and future-with conditions for all groups except tenants, who experience a decline in net income of 11%. The reason for this outcome is basically that a small shift in cropping has a larger proportionate impact on tenants' incomes than on other groups. In addition, tenants start off with a greater proportion of higher land and have a cropping pattern less adjusted to flooding conditions, whereas the other farmer groups all grow some deepwater aman.

Table I.2. also shows that the distribution of village income remains unchanged. Large farmers, who comprise 7% of farming households, receive 26% of net farm income, while tenants, who make up 12% of households, receive 1% of net farm income. These are the extremes however: small and medium farmers make up 81% of farm households and receive 74% of net farm income, so that overall income distribution is not too highly skewed. These, however, are 'first-round' effects without taking into account income to the leasers of land, sellers of water, providers of credit and draught power etc., who are generally the larger farmers.

Examining household-level net incomes under present conditions, incomes of large farmers exceed those of tenants by fifty times! Even small farmer incomes are more than six times greater than those earned by tenants.

B. Ghagoa.

Ghagoa is also in Pirgacha thana, further north from Digtari. It has a similar flood phase distribution to Digtari, and is similarly affected by the project. Table I.3 shows the flood phase distribution, and Table I.4 shows income changes. There is again a small shift to higher flood depths, and this time all farm size groups are adversely affected, although again tenants experience the greatest proprtionate decline in net income, for similar reasons as above. Tenants grow only HYV t.aman, whereas the other farm size groups grow equal amounts of HYV and local t.aman: tenants are therefore forced to make greater proportionate shifts in their cropping pattern than the other groups.

Village-level income distribution is again similar to Digtari. It is notable that small and medium farmers comprise 79% of farm households and receive 79% of net farm income.

C. Gopalcharan.

This village is south of Digtari, in Sunderganj thana, and has predominantly F1 and F2 land, as shown in Table I.5. Project interventions bring about a fall in water levels and an increase in farm incomes of all groups, as shown in Table I.6. In this case the proportionate increase in net incomes of 5% is the same for all groups, and the main change in cropping is an increase in HYV t.aman.

Small farmers predominate in this village, comprising 72% of all farm households, and receiving 45% of net farm income.

D. Kismat Malibari.

This village is in Gaibandha thana to the north east of the Manas river. It has high proportions of F1 and F2 land, and smaller amounts of F3 land. Project interventions bring about a substantial reduction in water levels and an increase in farm net incomes. The changes in flood phase distribution are shown in Table I.7 and changes in income shown in Table I.8. The proportionate income change is less for large farmers than for other groups, but in absolute terms their incomes increase substantially. (Present condition cropping patterns show that large farmers grow a far higher proportion of local t.aman to HYV t.aman than other farm size groups, and it is assumed that in future this situation will still hold to some extent). The main cause of increased incomes is more cultivation of HYV t.aman.

E. Manduar.

Manduar is in Sadullapur thana on the right bank of the Ghagot river. It has high proportions of F1 and F2 land, and fairly similar amounts of F0 and F3 land. It is subject to spills over the right bank of the Ghagot.

Table I.9 shows the flood phase distribution, and Table I.10 the income changes as a result of the project. Incomes increase for all groups, and particularly for tenants. The latter finding differs from the estimate in the Draft Final report and is probably more appropriate, in view of the fact that all other incomes increase. The size of increase for tenants is possibly overstated, since future-without incomes are predicted to be less than present incomes, a situation which may not in fact occur.

Even with an increase in incomes, tenants' incomes remain far below those of all other farm size groups. Small farmers' incomes are ten times those of tenants in all periods.

F. Parbagaria.

Parbagaria is in Gaibandha thana just to the north of the Manas regulator, has a high proportion of low-lying land and suffers from drainage congestion. As a result the proportion of t.aman grown is lower than in the other villages: conversely, the proportion of HYV boro is higher, and oilseeds are also a significant crop.

Table I.11 shows the flood phase distribution, and Table I.12 the income changes. The project is not able to remove the drainage congestion problem fully, but it does bring about some reduction in flooding depths which is reflected in increases in farm incomes. The main change is some increase in local and HYV t.aman, partially offset by a reduction in oilseeds. Again the proportionate change of large farmers is less than for other groups.

Conclusions.

The analysis described above should be regarded as indicative rather than precise, since it is difficult to predict with accuracy what changes in flood levels are going to occur, especially at village level. Predictions of cropping pattern changes are also only approximations.

Nonetheless, the analysis tends to show that the direction of income change in a specific location tends to be the same for all farm size groups, although the proportionate and absolute changes may differ. The project interventions have relatively little impact on income distribution at village level, although absolute income increases at household level tend to be larger as farm sizes increase, a predictable result. Tenants' incomes remain far below those of any other group.

A further point not yet made is that the income change between present and future-without conditions is generally larger than that between future-without and future-with conditions. The former change essentially reflects the assumed impact of irrigation growth, while the latter reflects the assumed impact of flood control.

7.4 Impact Matrix

Table 7.1 summarises the assessment of impacts for the project. The table compares the future situation with and without the project, both inside the project area and outside it, for option N (which has all project components but without compartmentalisation) and Option O, which is the base option. It can be seen that changes due to the project are often relatively small.

The impact analysis shows that Gaibandha development without compartmentalisation is likely to be the more benign strategy. All the negative impacts of this option are reproduced for the compartmentalisation option but are magnified in a number of important areas, including :

- the potential for public cutting
- the greater likely potential for the spread of water-related disease

This conclusion has to be weighed against the major improvement in the equity of spread of flood water in the system overall which can only be achieved through the strategy of compartmentalisation. Herein also lie the major economic benefits of investment which cannot be achieved to the same extent if development without compartmentalisation were selected.

As the economic and equity potential of compartmentalisation is significantly greater, it has been taken through as the most likely preferable option for future implementation. However, great priority must be placed upon being able to resolve the likelihood of differential water levels between drainage cells before this option should be decided on as the actual option for investment. Similarly, whichever option is finally selected, a proper survey tied to design and detailed mitigation planning must be carried out on the risks and management of water-related diseases.

The study therefore concludes that sufficient flexibility must be maintained during design and implementation to allow future changes in design and selection of tactics. This must be adequately represented in the TOR. Also, the future phasing of surveys, studies and design must be carried out in such a fashion as to ensure that the correct information is available and phased to allow proper design and decision making to occur.

Table 7.1 Assessment of Impacts for GIP

Resource Issue/Important Environmental Component	Option N				Option O			
PHYSICAL RESPONSES	INSIDE		OUTSIDE		INSIDE		OUTSIDE	
	FWO	FW	FWO	FW	FWO	FW	FWO	FW
WATER								
- Surface Water								
Peak levels	0	+1	0	+3	0	+4	0	+3
Flood frequency and duration	0	+1	0	+3	0	+4	0	+3
Drainage conditions	0	+1	0	+3	0	+4	0	+3
Morphological change	0	-1	-5	-5	0	0	-5	-5
Quality	0	-3	0	0	0	-4	0	0
- Groundwater, Wetlands and Waterbodies								
Recharge in highland	0	-1	0	-1	0	-1	0	-1
Wetland extent and recharge	0	0	0	-4	0	-2	0	-4
Seasonal availability	0	-1	0	-1	0	-1	0	-1
Quality	0	-1	0	-1	0	-1	0	-1
LAND								
Fertility	0	-2	0	-2	0	-2	0	-2
Physical status	0	-2	0	-2	0	-2	0	-2
Moisture status	0	-2	0	-2	0	-2	0	-2
Erosion or sedimentation	0	+2	0	+2	0	+2	0	+2
Disposal of construction spoil	0	0	0	0	0	0	0	0
BIOLOGICAL RESPONSES								
TERRESTRIAL ECOSYSTEM								
Habitat diversity	0	0	0	0	0	0	0	0
Wildlife habitats	-3	-4	-3	-4	-3	-4	-3	-4
Faunal species diversity	-3	-4	-3	-4	-3	-4	-3	-4
Floral species diversity	-3	-4	-3	-4	-3	-4	-3	-4
Pests and diseases	-3	-4	-3	-4	-3	-4	-3	-4
AQUATIC ECOSYSTEM								
Habitat diversity	-1	-2	-1	-3	-1	-2	-1	-3
Habitats for threatened species	-1	-2	-2	-2	-1	-2	-2	-3
Faunal species diversity	-2	-3	-2	-3	-2	-3	-2	-3
Floral species diversity	-1	-2	-1	-3	-1	-2	-1	-3
Pests and diseases	-2	-3	-2	-3	-2	-3	-2	-3
Wetland functions and productivity	-2	-3	-2	-3	-2	-3	-2	-3

Impact Issue/Important Environmental Component	Option N				Option O			
HUMAN RESPONSES	INSIDE		OUTSIDE		INSIDE		OUTSIDE	
	FWO	FW	FWO	FW	FWO	FW	FWO	FW
HAZARD LOSSES								
Normal flood damage	0	+4	0	+4	0	+4	0	+4
Extreme flood damage	-5	-5	-5	-5	-5	-5	-5	-5
Drought losses	0	-1	0	-1	0	-1	0	-1
Liquefaction	-4	-4	-4	-4	-4	-4	-4	-4
SUSTAINABLE RESOURCE USE								
Cropping	-3	-4	-3	-4	-3	-4	-3	-4
Fuel and energy	-4	-4	-4	-4	-4	-4	-4	-4
Common property	-3	-3	-3	-3	-3	-3	-3	-3
Capture fisheries	-2	-4	-2	-4	-2	-4	-2	-4
Culture fisheries	0	+3	0	+3	0	+3	0	+4
Livestock	-2	+1	-2	+2	-2	+1	-2	+2
Traditional medicines	-2	-2	-2	-2	-2	-2	-2	-2
INCOMES AND EMPLOYMENT								
Construction work	0	+2	0	0	0	+3	0	0
Agriculture	0	+4	0	+4	0	+4	0	+4
Fisheries	0	-3	0	-3	0	-3	0	-3
Navigation	0	-1	0	-2	0	-1	0	-2
Landless	0	+2	0	+1	0	+4	0	+2
Equity	0	-1	0	-1	0	-1	0	-1
SOCIAL								
Community and family cohesion	0	+3	0	+3	0	-3	0	+3
Impacts on women	0	+3	0	+3	0	+3	0	+3
Impacts on children	0	+2	0	+2	0	+2	0	+2
Minority groups	0	0	0	0	0	0	0	0
Access to flood survival strategies	-2	+1	-2	-2	-2	+1	-2	+2
Attitudes to flood risks	-3	+4	-3	+4	-3	+4	-3	+4
Land acquisition displacement	0	-2	0	-3	0	-3	0	-3
Settlement patterns	0	0	0	0	0	0	0	0
INSTITUTIONAL								
Public participation	0	+4	0	+4	0	?	0	0
Institutional complexity	0	0	0	0	0	-4	0	0

Impact Issue/Important Environmental Component	Option N				Option O			
HUMAN RESPONSES	INSIDE		OUTSIDE		INSIDE		OUTSIDE	
	FWO	FW	FWO	FW	FWO	FW	FWO	FW
NUTRITION AND HEALTH								
Entitlements	-2	-3	-2	-3	-2	-3	-2	-3
Food diversity	-2	-3	-2	-3	-2	-3	-2	-3
Nutritional disorders	-2	-3	-2	-3	-2	-3	-2	-3
Waterborne disease incidence	0	-2	0	-5	0	-5	0	-0
Sewage and sanitary systems	0	-2	0	-2	0	-4	0	-4
CULTURAL								
Cultural diversity	-2	-3	-2	-3	-2	-3	-2	-3
Cultural activities	0	-2	0	-3	0	-2	0	-3
Archaeological, cultural and religious sites	-2	-4	0	0	-2	-4	0	0
INFRASTRUCTURE								
Road network	0	+1	0	0	0	+2	0	0
Navigation Network	0	-1	0	-2	0	-2	0	-2

+1 = Slightly Beneficial, +2 = Somewhat Beneficial, +3 = Beneficial, +4 = Very Beneficial, +5 = Highly Beneficial
0 = No Response, Effect or Trend Detectable,
-1 = Slightly Negative, -2 = Somewhat Negative, -3 = Negative, -4 = Very Negative, -5 = Highly Negative

OPTION 1 = Full FCD without Drainage Cells
OPTION 2 = Full FCD with Drainage Cells

CHAPTER 8

SUSTAINABILITY

8.1 Institutional Issues

As far as possible the aim should be to implement and manage the project through existing institutions and to develop and strengthen them as needed. Thus it is expected that government agencies such as BWDB, LGED, DAE, DOF as well as the local government structure will be involved as they are at present on flood prevention work. In addition there will be a need to include into the management structure NGOs and others who can play a leading role in establishing and supporting public participation. A possible institutional arrangement is given in Figure 8.1, which shows the involvement of the various agencies in the different components of the project.

Traditionally great emphasis has been put on project committees to obtain the necessary interaction between different departments and institutions. There is a need for such committees but there is also a danger that they are so big that they are not effective.By the time the Gaibandha project comes to be implemented, useful experience will be available from FAP20 on institutional arrangements for projects of this type. In the meanwhile, it is suggested that these should be a pilot experiment with a much smaller form of committee, composed of the BWDB Executive Engineer, the LGED Executive Engineers and a well-respected member of the NGO community. The committee should be chaired by the District Commissioner, who would be responsible for ensuring that there was the necessary co-ordination, particularly will other agencies and with the local government structure. He would also be able to ensure that the project initiatives complemented other developments in the district.

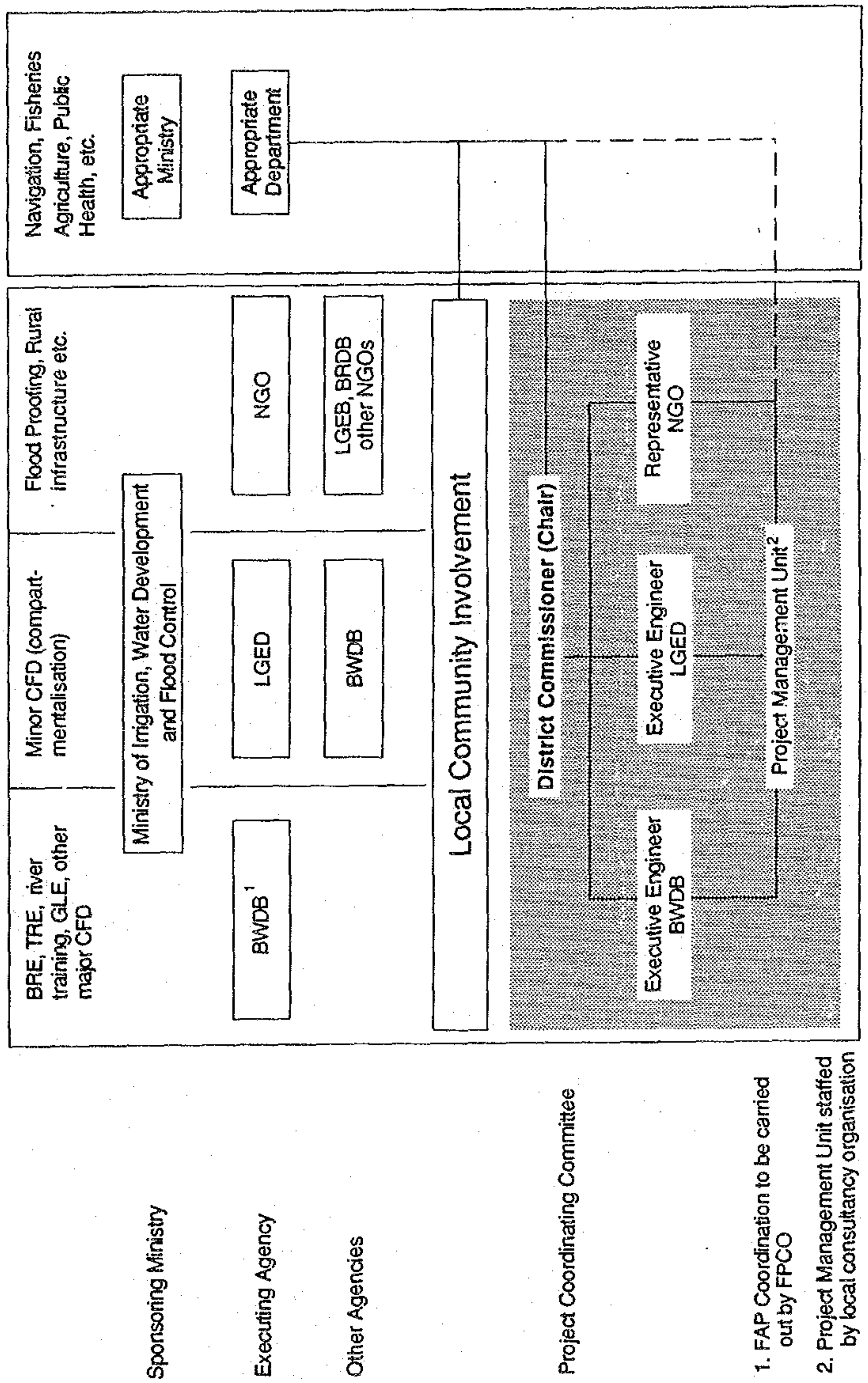
In making decisions on institutional issues and implementation it should be noted that Gaibandha, in common with the rest of the North West region is a dynamic landscape. Works which relate closely to the project concept are already in hand by others (for instance the study being undertaken by SRP on a scheme in the south of the project area near Gaibandha town, Kumarnai Bundh). There may also be an urgent need to make long-term decisions concerning the Ghaghot/Brahmaputra confluence during 1993, if the existing Manas Regulator is washed away. Therefore there should be the intention to try to mesh the proposed institutional set-up with that already existing, so that there is an integrated approach to the problems of Gaibandha, and duplication of effort is avoided.

It is envisaged that support will be necessary to the project committee.This should be provided through a Project Management Unit (PMU), directly funded as part of the project. The PMU would be a consultancy team who could have a variety of functions such as:

- ensuring good standards of project management and quality control;
- initiating and supervising necessary monitoring and technical investigations, such as modelling;
- ensuring that methods of construction and maintenance are developed which maximise benefits to poor groups;
- ensuring a smooth transition to operation and maintenance as the works are constructed;

Figure 8.1

Project Institutional Arrangements



1. FAP Coordination to be carried out by FPCO
2. Project Management Unit staffed by local consultancy organisation

- transferring skills, for instance in planning and construction.
- ensuring consultation with the public; and
- coordinating associated development activities.

Again the experience of FAP20 will be important in determining the exact structure of the PMU. It is expected that most of the necessary skills could be available through local consultancy organisations,with involvement of other local organisations such as NGOs. Some foreign expertise might be useful, to provide cross-fertilisation of ideas from other countries.

Some training will be necessary for the staff involved in implementing and managing the project. This should be directed towards the goal of managing sustainable development within the Gaibandha area, and would have three main aspects:

1) management skills to ensure that the project is efficiently and effectively managed;

2) institutional development, to ensure a successful partnership between government agencies, NGOs and local people.

3) the sustainable use of natural resources, relating particularly to water, land, agriculture and fisheries.

8.2 Public Participation

At an immediate and practical level, there is a need to stimulate an on-going and vigorous involvement of local people in the development of the project. Detailed discussions and participation are required for the next stage of detailed design, to ensure that, as far as possible, the designs meet the needs and aspirations of the people. A good start on this has been made with the consultation carried out by the NWRS study team but there is now a need to put in place a mechanism which would allow a continuous dialogue to take place. NGOs have an obvious role to play in this process but it will be necessary first to establish positive working relationships between them and the government agencies responsible for the detailed designs, in particular BWDB.

Beyond that, mechanisms must be drawn up to allow local people to become involved in implementation, both to realise the immediate benefits of construction employment and also so that they develop a sense of ownership of the facilities. Various models have been developed for this and there are already NGOs within the project area, such as GKK (Section 2.6), who have experience of forming and supporting LCS to undertake project works.

When implementation is completed, there will then be an on-going need for local participation in O&M. This is discussed more fully in section 8.4.

Whilst there are many problems to be faced, the Gaibandha project has the advantage that many of its major measures, such as sealing the Teesta embankment, improving the drainage at the Ghagot outfall, and reducing flooding down the Alai, meet with very widespread approval. There should not therefore be difficult conflicts to resolve during the process. The next stage, after the major measures have been put in hand, is more difficult since it involves areal development and the balance of conflicting interests, between farmer and farmer, farmer and fisherman, fisherman and boatman and so on. The PMU's importance is likely to increase at that time.

8.3 Benefits to Poor Groups

Although a significant proportion of project benefits will of necessity go to those who own land, it is essential to also target benefits to poor groups as far as possible. Gaibandha district is one of the poorest districts in the NW region, which is one reason why a significant investment in the district should have high priority. A larger proportion of the male labour force has to migrate each year, leaving women to look after children on very limited incomes. In addition, a substantial population now lives on charlands and the main river embankments.

Increases in agricultural production will generate more work for agricultural labourers, but the increases foreseen are not enough to tackle the poverty problem. While an effective anti-poverty strategy will require involvement of many agencies and other projects and programmes, much can be done within the scope of the Gaibandha project. The proposed PMU will have responsibility to promote much of the poverty-focused work.

The first aim should be to maximise construction employment and income going to poor groups. Often the former is easier than the latter, as members of project committees or contractors sometimes fail to pay proper wages. The system of Labour Contracting Societies (LCS), if properly organised and supervised, can ensure both fair payment to labourers and good quality work. This system should be adopted as widely as is feasible. Womens' groups can also be involved in this work.

The use of LCS groups need not be limited to earthworks. There will be a need for large quantities of cement blocks for river bank protection, pipe sluices for compartmentalisation, and C.I rings for sanitary latrines under the flood proofing programme. All of these items could in principle be fabricated by poor groups given some training (the experience of LGED's RESP programme in Kurigram and Faridpur Districts is generally encouraging in relation to pipe culvert fabrication).

A further aim of the project should be to promote natural resource development which spreads benefits widely. The proposals for fisheries development (see section 5.4.1) are particularly important, given both the relative poverty of the fishing community and the nutritional importance of having fish more widely available in the market.

Broader income-generation activities need to be identified, and developed. While there are many government and NGO programme already operating, they clearly do not satisfy the need for work. This need should be focused on women as a priority, in view of the high rates of male seasonal out-migration already mentioned.

Since some of the poorest women live on the main river embankments, there should be specific focus on the productive use of those embankments for example to grow pulses or some vegetables (although technical and legal obstacles would first have to be cleared). Work done by MPO [FCDI Projects and the Productive Use of Resources, Centre for Development Research 1985] explores this potential in detail.

Clearly, in addition to the above, the overall demand for work needs to be tackled through specific poverty-focused programmes with provision for credit and training.

Although employment and income (productive needs) are priorities (as expressed by poor people themselves), the project can also contribute in the area of reproductive needs - health and security from the impact of floods being two major areas. The former should be addressed in the next stage of detailed project design, where the health implications of project proposals must be scrutinised.

In addition, however, the overall health and nutrition status, particularly of embankment dwellers, is poor, and this needs to be addressed, not just through medical-related campaigns, but through the fisheries developments and vegetable cultivation projects already discussed.

The issue of security from flooding is addressed by the flood proofing programme, which should be seen in the broadest sense, not just to provide immediate shelter, but also to provide rehabilitation to restore people's economic position.

8.4 Operation and Maintenance

Effective operation and maintenance has been correctly identified as a major problem in achieving the expected benefits from flood control investments. The problems and recent developments have been fully documented in the FAP13 study, and are summarised in the Regional Plan Final Report.

There are two major problems related to the O&M of a project such as the Gaibandha Improvement Project. The first relates to the operation of the project, and particularly its structures.The second relates primarily to the maintenance of the major works , which are the main river embankments. These two problems are underlain by a third problem, relating to institutional issues - which agency or institution is to be responsible for O&M, and how will O&M be funded.

At the present stage it is not possible to be definite about how these problems will be tackled, but various approaches can be investigated and developed during the implementation phase.This should be in co-ordination with other programmes working on O&M, such as SSFCDI, EIP, SRP and others. It is also possible that the Gaibandha project could form a pilot project for the second phase of FAP13, the O&M study. As with planning, one important aspect of work at Gaibandha will be to integrate the work of others: this particularly relates to SRP's development of Kumarnai Bundh, and the recently-completed Satdamua-Katler-Beel embankment of EIP.

Consideration has been given to designs that reduce O&M requirements: for example, embankment design makes allowance for embankment dwellers to live on a berm inside the embankment rather than on the embankment where they may cut it. Automatic structures have been considered as an alternative to manually-operated structures to regulate drainage flows. However it is considered that these structures would be vulnerable to non-operation during an emergency, and might also be more costly than manual structures.

In relation to structure operation, the proposed project committee and PMU have an important role in fostering local involvement so that the balance of interest and trade-offs between different groups are known and understood by all before structures are built. It will then be necessary to persevere with the concept of gate committees, even though experience to date with them has not been very encouraging, utilizing the same groups for operation that were involved in the planning, detailed design and construction. More intensive attention to issues of how to resolve conflicts on water availability and drainage at local level will be necessary at all stages of project development.

Concerning maintenance, the major problem relates to the main river embankments.One aspect of this is the deterioration of the section due to human habitation and interference; attempts to improve this situation include the provision of a wide berm on the landward side of the embankment for habitation and cultivation. A more serious problem relates to continued erosion by the rivers. In this respect the work of FAP1 and FAP21/22 is important in determining the most economic methods of providing permanent solutions to the problems of erosion.

Institutional issues related to O&M are difficult to resolve and experience from other programmes will be very important in this respect. An important objective of the work of the project committee and the PMU will be to develop, during the period of implementation, local forms of involvement and awareness so that institutions are established which can take over the O&M of the facilities as they are constructed. This will itself go some way to resolve the problems of resources for O&M; if local people are involved and see the benefit, they will be ready to contribute part of the requirement through their own labour. However, this will not provide all the resources needed for O&M. For the foreseeable future it seems unlikely that this can be raised directly from the beneficiaries: experience from most Asian countries is that cost recovery is very poor, even for schemes providing the direct benefit of irrigation water. O&M resources will therefore have to be provided from central funds, as at present, but greater efforts will be needed to channel them directly to the facilities themselves, rather than to the staff establishment, as at present.

Training of different personnel involved in O&M will be an important component. Proposals on the nature of training required should be developed consistent with the adopted organisational structure.

CHAPTER 9

CONCLUSIONS

9.1 Multi-Criteria Analysis

The multi-criteria analysis for the project is summarised in Table 9.1 (These criteria are the same as those used for regional planning and are discussed in Chapter 8 of the Regional Plan Final Report.

Table 9.1 Gaibandha Improvement Project Multi-Criteria Analysis

Net Cultivated Area (ha)	49130
(including d/s benefitted area)	197780
Total Cost	Tk 1670 million
IRR	10 %
Rice Output	335,000 tonnes (+8 %)
Total Fish Output	675 (-3 %) tonnes
Construction Employment	9.76 million days
Annual Agricultural Employment	20 million days (+6 %)
Land Acquisition (ha)	425
Net impacts on biophysical environment	Zero
Net impacts on social conflict	+1
Institutional Complexity	Zero
Susceptibility to Hazard	Zero
External Impacts	+2

The rate of return puts the project in the marginal category in basic economic terms, but it is nonetheless recommended for implementation. There are a number of reasons for recommending that the project be taken up:

- The benefit assessment may be understating the full benefits to be gained in the wider impact area particularly from sealing the Teesta upstream. The analysis at this stage did not allow an assessment of potential changes in cropping patterns in the impact area (except for the Alai area).

- The risks of not undertaking the most costly works, i.e. river training work on the Teesta, could be considerable. If the Teesta was not sealed downstream, for example, and the compartmentalisation works were used instead to give flood protection, the risks of erosion would be great. If, instead of river training, the embankment was retired, this option would again result in considerable erosion losses.

- The option of bank protection is strongly supported by all people living in the area; conversely, continued retirement and land acquisition increase landlessness and poverty.

- The costs of the project include work on the BRE at the outfall of the Ghagot which has no direct agricultural benefit but is required to maintain the integrity of the BRE.

- The construction work creates almost 10 million man-days of employment, in an area of chronic under-employment and poverty. This work would make a significant contribution to development of what is a generally depressed area. It is further recommended that as much of this work as possible should be carried out through LCS groups, including women's groups, to maximise the income actually received by labourers, and to ensure good quality work.

- The increased agricultural output due to the project will result in approximately 1 million additional man-days of agricultural labour per year. While a significant percentage of this increase will be taken up by farm families themselves, it will still result in a substantial increase in employment for agricultural labourers.

- Other benefits from associated natural resource development can be targetted so that benefits to poor households are maximised (see section 8.3).

When reviewing the scores of the project against other criteria, it must be remembered that these are being used to rank it against other possible projects in the North West Region. Generally its impacts on the biophysical environment will be relatively neutral particularly if associated fisheries improvement measures are undertaken. It scores well in reducing social conflict and in beneficial impacts downstream, for instance reduction in flows down the Alai will increase productivity in the Sonail scheme and reduce the conflicts which regularly lead to public cuts of the embankment. In general, planning for the Gaibandha project has tried to reduce disbenefits and causes for conflict to the extent possible.

The project as formulated has no major negative impacts which would be sufficient to cause its rejection.

9.2 Future Action

It is recommended that GOB should proceed with implementation of the Gaibandha project immediately, and should seek to secure the necessary level of funding for it. This should be done in the knowledge that a long implementation period is expected,and that considerable further work will be required before the exact physical configuration can be determined for some of the works.

The works required for sealing of the Teesta are well defined and do not have complex relationships with other parts of the project. These can proceed to modelling and detailed design immediately. There will also be a need to take early decisions on how to incorporate the on-going work of others (particularly SRP at Kumarnai Bundh) in the Gaibandha Improvement Project, and actions to be taken in the likely event that the Manas Regulator will be washed away in 1993.

There is a need to put in hand immediately the necessary institutional structure for managing the implementation of the project.This includes setting-up the project committee and the project management unit, as a first step to taking more far-reaching decisions about institutional structures for the project.

Further investigations and studies that are needed include:

- hydraulic and hydrological observation for updating the model and improving it for the design of the compartmentalisation of the project;

- further rounds of public consultation, particularly related to compartmentalisation;

- formulation of a flood proofing programme;

- analysis of fisheries, navigation and health aspects for incorporation into the areal development plan.

APPENDIX I

AGRO-ECONOMIC SURVEY TABLES

TABLE I.1 CHANGES IN FLOOD PHASE DISTRIBUTION BY FARM SIZE GROUP
VILLAGE: DIGTARI

FARM SIZE	PRESENT/FUTURE-WITHOUT (%)			
	F0	F1	F2	F3/F4
GROUP				
TENANT S/C LAND	0	20	80	0
TENANT OWN LAND	0	15	85	0
SMALL FARMER S/C LAND	10	0	0	90
SMALL FARMER OWN LAND	2	20	57	21
MEDIUM FARMER OWN LAND	0	5	57	38
LARGE FARMER OWN LAND	0	0	54	46
	FUTURE (%)			
	F0	F1	F2	F3/F4
TENANT S/C LAND	0	0	0	0
TENANT OWN LAND	0	0	85	15
SMALL FARMER S/C LAND	0	10	0	90
SMALL FARMER OWN LAND	0	18	57	25
MEDIUM FARMER OWN LAND	0	2	57	41
LARGE FARMER OWN LAND	0	0	50	50

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TABLE I.2 FARM-LEVEL INCOME CHANGES
VILLAGE: DIGTARI

COSTS AND INCOME PER HH.

FARM SIZE GROUP		GROSS RETURN	CASH COST OF INPUTS	FULL COST OF INPUTS	NET RETURN CASH COST BASIS	NET RETURN FULL COST BASIS	NET INCOME	NO. OF HHS IN VILLAGE IN FARM SIZE GROUP	NET INCOME AT VILLAGE LEVEL	% FARM HHS	% AGRIC. NET INCOME
TENANT	PRESENT	2338	1062	1803	1277	536	1175	15	17620		
	FUT. W/O	2364	1072	1809	1292	555	1197	15	17955		1
	FUT. W.	2158	1004	1669	1154	489	1065	15	15975	12	1
	% CHANGE										
	W/O TO W.	-9	-6	-8	-11	-12	-11		-11		
SMALL FARMER	PRESENT	11650	3201	5069	8449	6581	7767	70	543690		
	FUT. W/O	13828	4106	6218	9722	7610	8942	70	625940		30
	FUT. W.	13828	4106	6218	9722	7610	8942	70	625940	54	30
	% CHANGE										
	W/O TO W.	0	0	0	0	0	0		0		
MEDIUM FARMER	PRESENT	35057	8559	13264	26499	21794	23602	35	826070		
	FUT. W/O	41323	11510	16922	29814	24401	26419	35	924665		44
	FUT. W.	41323	11510	16922	29814	24401	26419	35	924665	27	44
	% CHANGE										
	W/O TO W.	0	0	0	0	0	0		0		
LARGE FARMER	PRESENT	82358	24565	35947	57793	46411	49088	9	441792		
	FUT. W/O	103422	32569	46757	70853	56665	59818	9	538362		26
	FUT. W.	103422	32569	46757	70853	56665	59818	9	538362	7	26
	% CHANGE										
	W/O TO W.	0	0	0	0	0	0		0		
									2106922		
								129	2104942		

Note: Returns and income for tenants and small farmers comprise final receipts from own and sharecropped land where relevant, i.e. receipts from sharecropped land after deduction of 50% share for landlord.

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TABLE I.3 CHANGES IN FLOOD PHASE DISTRIBUTION BY FARM SIZE GROUP
VILLAGE: GHAGOA

FARM SIZE	PRESENT/FUTURE-WITHOUT (%)			
	F0	F1	F2	F3/F4
GROUP				
TENANT S/C LAND	0	50	34	16
TENANT OWN LAND	0	0	0	0
SMALL FARMER S/C LAND	0	30	16	54
SMALL FARMER OWN LAND	0	47	20	33
MEDIUM FARMER OWN LAND	3	29	33	35
LARGE FARMER OWN LAND	0	16	31	53
	FUTURE (%)			
	F0	F1	F2	F3/F4
TENANT S/C LAND	0	41	41	18
TENANT OWN LAND	0	0	0	0
SMALL FARMER S/C LAND	0	24	19	57
SMALL FARMER OWN LAND	0	43	23	34
MEDIUM FARMER OWN LAND	0	25	37	38
LARGE FARMER OWN LAND	0	14	32	54

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TABLE I.4 FARM-LEVEL INCOME CHANGES
VILLAGE: GHAGOA

COSTS AND INCOME PER HH.

FARM SIZE GROUP		GROSS RETURN	CASH COST OF INPUTS	FULL COST OF INPUTS	NET RETURN CASH COST BASIS	NET RETURN FULL COST BASIS	NET INCOME	NO. OF HHS IN VILLAGE IN FARM SIZE GROUP	NET INCOME AT VILLAGE LEVEL	% FARM HHS	% AGRIC. NET INCOME
TENANT	PRESENT	3950	1952	2933	1676	1017	1894	32	60608		
	FUT. W/O	4292	2375	3426	1917	865	1794	32	57408		2
	FUT. W.	4129	2324	3346	1805	783	1685	32	53920	17	2
	% CHANGE W/O TO W.	-4	-2	-2	-6	-9	-6		-6		
SMALL FARMER	PRESENT	18870	5114	7898	13757	10972	12643	127	1605661		
	FUT. W/O	19611	5515	8417	14097	11194	12933	127	1642491		56
	FUT. W.	19387	5482	8353	13905	11034	12757	127	1620139	68	56
	% CHANGE W/O TO W.	-1	-1	-1	-1	-1	-1		-1		
MEDIUM FARMER	PRESENT	45755	12185	18046	33570	27709	29939	21	628719		
	FUT. W/O	51243	14584	21000	36659	30243	32576	21	684096		23
	FUT. W.	50459	14370	20723	36090	29736	32051	21	673071	11	23
	% CHANGE W/O TO W.	-2	-1	-1	-2	-2	-2		-2		
LARGE FARMER	PRESENT	95687	28777	41309	66910	54378	56979	8	455832		
	FUT. W/O	124537	39668	56014	84869	68523	71704	8	573632		19
	FUT. W.	124073	39588	55910	84485	68163	71327	8	570616	4	20
	% CHANGE W/O TO W.	-0	-0	-0	-0	-1	-1		-1		
									2957627		
								188	2917746		

Note: Returns and income for tenants and small farmers comprise final receipts from own and sharecropped land where relevant, i.e. receipts from sharecropped land after deduction of 50% share for landlord.

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TABLE I.5 CHANGES IN FLOOD PHASE DISTRIBUTION BY FARM SIZE GROUP
VILLAGE: GOPALCHARAN

FARM SIZE	PRESENT/FUTURE-WITHOUT (%)			
	F0	F1	F2	F3/F4
GROUP				
TENANT S/C LAND	0	12	76	12
TENANT OWN LAND	8	12	80	0
SMALL FARMER S/C LAND	0	35	48	17
SMALL FARMER OWN LAND	0	45	44	11
MEDIUM FARMER S/C LAND	0	74	26	0
MEDIUM FARMER OWN LAND	3	43	53	1
LARGE FARMER OWN LAND	2	35	39	24
	FUTURE (%)			
	F0	F1	F2	F3/F4
TENANT S/C LAND	4	18	69	9
TENANT OWN LAND	16	16	68	0
SMALL FARMER S/C LAND	3	42	41	14
SMALL FARMER OWN LAND	3	51	39	7
MEDIUM FARMER S/C LAND	5	79	16	0
MEDIUM FARMER OWN LAND	6	49	44	1
LARGE FARMER OWN LAND	5	40	35	20

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TABLE I.6 FARM-LEVEL INCOME CHANGES
VILLAGE: GOPALCHARAN

COSTS AND INCOME PER HH.

FARM SIZE GROUP		GROSS RETURN	CASH COST OF INPUTS	FULL COST OF INPUTS	NET RETURN CASH COST BASIS	NET RETURN FULL COST BASIS	NET INCOME	NO. OF HHS IN VILLAGE IN FARM SIZE GROUP	NET INCOME AT VILLAGE LEVEL	% FARM HHS	% AGRIC. NET INCOME
TENANT	PRESENT	7255	3712	5464	3542	1790	3302	15	49530		
	FUT. W/O	7402	3789	5510	3612	1892	3379	15	50685		1
	FUT. W.	7609	3836	5575	3774	2034	3546	15	53190	7	1
	% CHANGE W/O TO W.	3	1	1	4	8	5		5		
SMALL FARMER	PRESENT	16094	4608	7206	11487	8888	10430	160	1668800		
	FUT. W/O	19419	5812	8794	13607	10625	12402	160	1984320		45
	FUT. W.	20155	5912	8991	14244	11165	12991	160	2078560	72	45
	% CHANGE W/O TO W.	4	2	2	5	5	5		5		
MEDIUM FARMER	PRESENT	63538	16881	24680	46657	38858	41732	35	1460620		
	FUT. W/O	71839	20306	28986	51533	42853	45953	35	1608355		36
	FUT. W.	74801	20890	29835	53911	44966	48061	35	1682135	16	36
	% CHANGE W/O TO W.	4	3	3	5	5	5		5		
LARGE FARMER	PRESENT	93477	27229	39448	66248	54029	56834	12	682008		
	FUT. W/O	114501	35325	50307	79176	64194	67346	12	808152		18
	FUT. W.	118852	36099	51562	82753	67290	70551	12	846612	5	18
	% CHANGE W/O TO W.	4	2	2	5	5	5		5		
									4451512		
								222	4660497		

Note: Returns and income for tenants and small farmers comprise final receipts from own and sharecropped land where relevant. i.e. receipts from sharecropped land after deduction of 50% share for landlord.

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TABLE I.7 CHANGES IN FLOOD PHASE DISTRIBUTION BY FARM SIZE GROUP KISMAT MALIBARI VILLAGE

	PRESENT/FUTURE-WITHOUT (%)			
FARM SIZE	F0	F1	F2	F3/F4
GROUP				
TENANT S/C LAND	0	14	27	59
TENANT OWN LAND	0	50	50	0
SMALL FARMER S/C LAND	22	52	12	14
SMALL FARMER OWN LAND	5	37	43	15
MEDIUM FARMER OWN LAND	1	34	42	23
LARGE FARMER OWN LAND	1	32	43	24
	FUTURE (%)			
	F0	F1	F2	F3/F4
TENANT S/C LAND	21	20	21	38
TENANT OWN LAND	25	50	25	0
SMALL FARMER S/C LAND	41	46	6	7
SMALL FARMER OWN LAND	22	37	31	10
MEDIUM FARMER OWN LAND	20	34	31	15
LARGE FARMER OWN LAND	20	32	32	16

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TABLE I.8 FARM-LEVEL INCOME CHANGES
VILLAGE: KISMAT MALIBARI

COSTS AND INCOME PER HH.

FARM SIZE GROUP		GROSS RETURN	CASH COST OF INPUTS	FULL COST OF INPUTS	NET RETURN CASH COST BASIS	NET RETURN FULL COST BASIS	NET INCOME	NO. OF HHS IN VILLAGE IN FARM SIZE GROUP	NET INCOME AT VILLAGE LEVEL	% FARM HHS	% AGRIC. NET INCOME
TENANT	PRESENT	7147	3717	5299	3430	1848	3166	8	25328		
	FUT. W/O	7928	4475	6223	3452	1705	3162	8	25296		2
	FUT. W.	8513	4661	6517	3852	1996	3552	8	28416	12	2
	% CHANGE W/O TO W.	7	4	5	12	17	12		12		
SMALL FARMER	PRESENT	14963	4792	7445	10171	7518	9119	35	319165		
	FUT. W/O	17778	5839	8784	11938	8994	10767	35	376845		24
	FUT. W.	19163	6019	9133	13144	10030	11880	35	415800	54	24
	% CHANGE W/O TO W.	8	3	4	10	12	10		10		
MEDIUM FARMER	PRESENT	52785	14651	21296	38133	31489	34539	14	483546		
	FUT. W/O	62859	18372	26279	44487	36580	39395	14	551530		35
	FUT. W.	68448	19378	27842	49070	40606	43588	14	610232	22	36
	% CHANGE W/O TO W.	9	5	6	10	11	11		11		
LARGE FARMER	PRESENT	123246	36545	52918	86702	70328	73642	8	589136		
	FUT. W/O	133695	40619	58357	93076	75338	78861	8	630888		40
	FUT. W.	138805	41526	59813	97279	78992	82646	8	661168	12	39
	% CHANGE W/O TO W.	4	2	2	5	5	5		5		
									1584559		
								65	1715616		

Note: Returns and income for tenants and small farmers comprise final receipts from own and sharecropped land where relevant. i.e. receipts from sharecropped land after deduction of 50% share for landlord.

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TABLE I.9 CHANGES IN FLOOD PHASE DISTRIBUTION BY FARM SIZE GROUP
VILLAGE: MANDUAR

FARM SIZE	PRESENT/FUTURE-WITHOUT (%)			
	F0	F1	F2	F3/F4
GROUP				
TENANT S/C LAND	21	31	21	27
TENANT OWN LAND	0	0	0	0
SMALL FARMER S/C LAND	0	47	53	0
SMALL FARMER OWN LAND	15	32	45	8
MEDIUM FARMER OWN LAND	6	31	47	16
LARGE FARMER OWN LAND	20	55	19	6
	FUTURE (%)			
	F0	F1	F2	F3/F4
TENANT S/C LAND	28	30	20	22
TENANT OWN LAND	0	0	0	0
SMALL FARMER S/C LAND	0	47	53	0
SMALL FARMER OWN LAND	20	32	42	6
MEDIUM FARMER OWN LAND	8	31	47	14
LARGE FARMER OWN LAND	27	51	18	4

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TABLE I.8 FARM-LEVEL INCOME CHANGES
VILLAGE: MANDUAR

COSTS AND INCOME PER HH.

FARM SIZE GROUP		GROSS RETURN	CASH COST OF INPUTS	FULL COST OF INPUTS	NET RETURN CASH COST BASIS	NET RETURN FULL COST BASIS	NET INCOME	NO. OF HHS IN VILLAGE IN FARM SIZE GROUP	NET INCOME AT VILLAGE LEVEL	% FARM HHS	% AGRIC. NET INCOME
TENANT	PRESENT	4543	3103	4397	1440	147	1204	25	30100		
	FUT. W/O	4515	3180	4427	1335	88	1103	25	27575		1
	FUT. W.	4823	3286	4503	1537	320	1340	25	33500	17	1
	% CHANGE W/O TO W.	7	3	2	15	264	21		21		
SMALL FARMER	PRESENT	21224	6243	9427	14981	11797	13704	83	1137432		
	FUT. W/O	22340	6894	10035	15446	12306	14164	83	1175612		50
	FUT. W.	22970	6737	10001	16233	12969	14883	83	1235289	56	51
	% CHANGE W/O TO W.	3	-2	-0	5	5	5		5		
MEDIUM FARMER	PRESENT	37079	8750	13671	28329	23408	25310	34	860540		
	FUT. W/O	42405	10981	16576	31424	25829	27978	34	951252		41
	FUT. W.	43500	11150	16858	32350	26642	28822	34	979948	23	40
	% CHANGE W/O TO W.	3	2	2	3	3	3		3		
LARGE FARMER	PRESENT	57560	15904	23991	41657	33569	35262	5	176310		
	FUT. W/O	63521	19073	27763	44448	35759	37483	5	187415		8
	FUT. W.	64433	19230	27968	45203	36466	38224	5	191120	3	8
	% CHANGE W/O TO W.	1	1	1	2	2	2		2		
									2341854		
								147	2439857		

Note: Returns and income for tenants and small farmers comprise final receipts from own and sharecropped land where relevant, i.e. receipts from sharecropped land after deduction of 50% share for landlord.

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TABLE I.11 CHANGES IN FLOOD PHASE DISTRIBUTION BY FARM SIZE GROUP
VILLAGE: PARBAGARIA

FARM SIZE	PRESENT/FUTURE-WITHOUT (%)			
	F0	F1	F2	F3/F4
GROUP				
TENANT S/C LAND	0	0	28	72
TENANT OWN LAND	0	0	0	0
SMALL FARMER S/C LAND	0	0	56	44
SMALL FARMER OWN LAND	0	9	47	44
MEDIUM FARMER OWN LAND	0	4	52	44
LARGE FARMER OWN LAND	0	8	22	70
	FUTURE (%)			
	F0	F1	F2	F3/F4
TENANT S/C LAND	0	21	25	54
TENANT OWN LAND	0	0	0	0
SMALL FARMER S/C LAND	0	16	50	34
SMALL FARMER OWN LAND	0	24	42	34
MEDIUM FARMER OWN LAND	0	20	47	33
LARGE FARMER OWN LAND	0	25	22	53

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TABLE I.12 FARM-LEVEL INCOME CHANGES
VILLAGE: PARBAGARIA

COSTS AND INCOME PER HH.

FARM SIZE-GROUP		GROSS RETURN	CASH COST OF INPUTS	FULL COST OF INPUTS	NET RETURN CASH COST BASIS	NET RETURN FULL COST BASIS	NET INCOME	NO. OF HHS IN VILLAGE IN FARM SIZE GROUP	NET INCOME AT VILLAGE LEVEL	% FARM HHS	% AGRIC. NET INCOME
TENANT	PRESENT	6293	3366	4497	2927	1796	2780	10	27800		
	FUT. W/O	6293	3366	4497	2927	1796	2780	10	27800		3
	FUT. W.	6641	3456	4666	3185	1975	3024	10	30240	14	3
	% CHANGE W/O TO W.	6	3	4	9	10	9		9		
SMALL FARMER	PRESENT	16298	5503	7668	10796	8630	10107	53	535671		
	FUT. W/O	16442	5608	7816	10835	8626	9964	53	528092		61
	FUT. W.	17243	5672	7980	11570	9263	10646	53	564238	74	61
	% CHANGE W/O TO W.	5	1	2	7	7	7		7		
MEDIUM FARMER	PRESENT	41923	12925	18376	28998	23547	25617	5	128085		
	FUT. W/O	52590	16861	23655	35730	28935	31468	5	157340		18
	FUT. W.	56190	17275	24452	38916	31738	34376	5	171880	7	19
	% CHANGE W/O TO W.	7	2	3	9	10	9		9		
LARGE FARMER	PRESENT	57560	15904	23991	41657	33569	35262	4	141048		
	FUT. W/O	63521	19073	27763	44448	35759	37483	4	149932		17
	FUT. W.	64433	19230	27968	45203	36466	38224	4	152896	6	17
	% CHANGE W/O TO W.	1	1	1	2	2	2		2		
									863164		
								72	919254		

Note: Returns and income for tenants and small farmers comprise final receipts from own and sharecropped land where relevant, i.e. receipts from sharecropped land after deduction of 50% share for landlord.

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