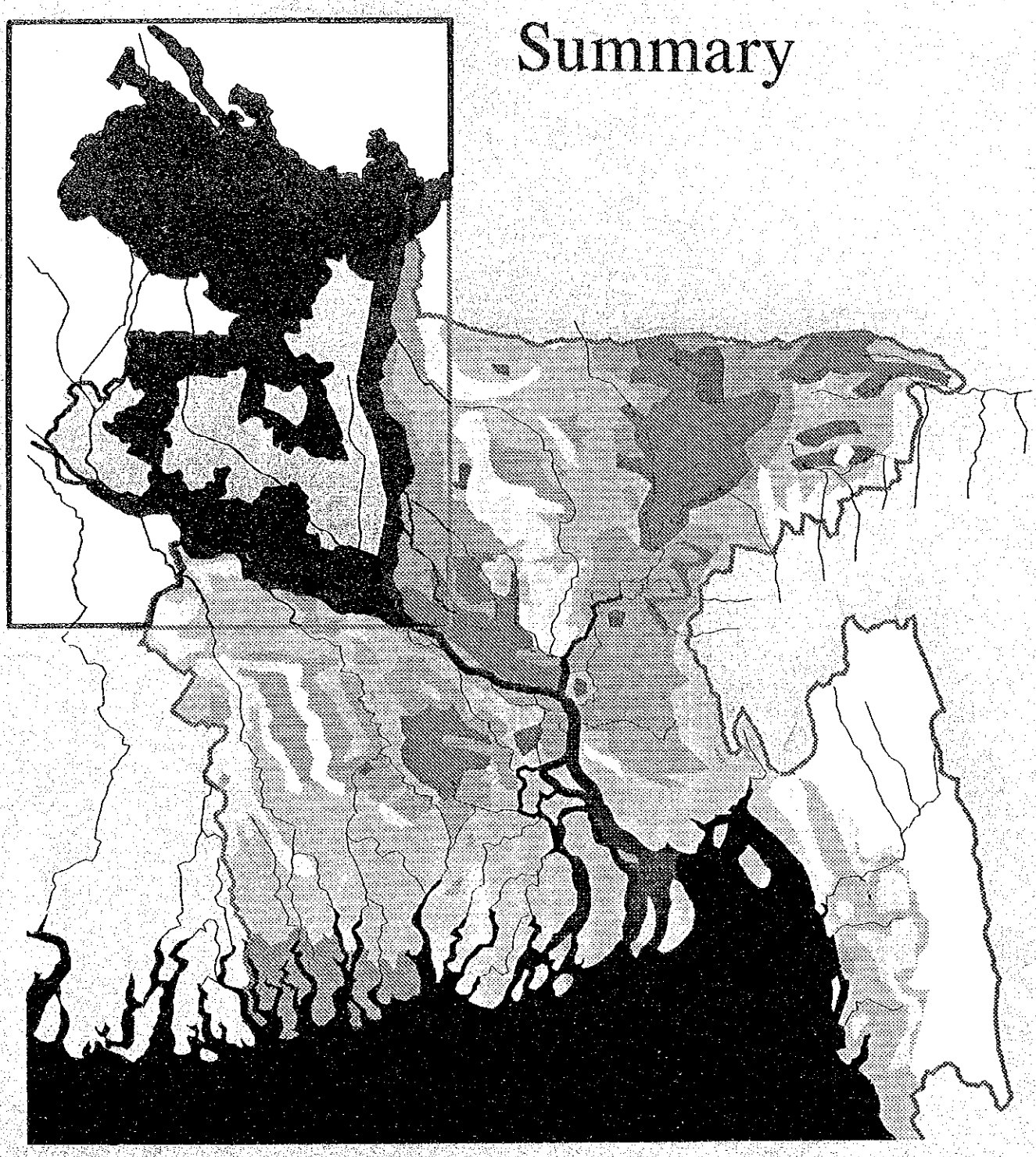
社会開発調査部報告書

No. 122

North West Regional Study (FAP2)

Summary



Overseas Development Administration, U.K.
Japan International Cooperation Agency

January 1993

Government of the Peoples Republic of Bangladesh
Flood Action Plan

NORTH WEST REGIONAL STUDY (FAP-2)

MOTT MACDONALD INTERNATIONAL
in association with
HYDRAULICS RESEARCH LTD.
HOUSE OF CONSULTANTS LTD.
under assignment to
OVERSEAS DEVELOPMENT ADMINISTRATION

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PREFACE

The North West Regional Study Final Report describes proposals for the Regional Water Development Plan and the results of the project preparation studies for the Gaibandha Improvement Project. It consists of the following volumes:

- Regional Plan Final Report
- Gaibandha Improvement Project Final Report
- Annexes to the Final Report

The Regional Plan Final Report is a revision of Volume 1, of the Draft Final Report. The Gaibandha Final Report is a revision of Volume 5 of the Draft Final Report. The Annexes contain the comments and responses on the Draft Final Report, together with additional supporting material.

The Draft Final Report, which was submitted in October 1992, consists of the following volumes :

Vol. 1	The Regional Plan
Vol. 2	Regional Data and Planning Units
Vol. 3	The Regional Plan - Engineering
Vol. 4	The Regional Plan - Initial Environmental Evaluation
Vol. 5	Gaibandha Improvement Project - Main Report
Vol. 6	Gaibandha Improvement Project - Engineering
Vol. 7	Gaibandha Improvement Project - Topographic Survey and Geotechnical Investigations
Vol. 8	Gaibandha Improvement Project - Environmental Impact Assessment
Vol. 9	Hydraulic Studies
Vol. 10	Hydrology and Groundwater
Vol. 11	Social Impacts
Vol. 12	Agriculture and Fisheries
Vol. 13	Economics
Vol. 14	Ecology
Vol. 15	Health, Navigation and Cultural Heritage

The first four volumes of the Draft Final Report describe the Regional Plan and aspects specifically related to regional planning. Volumes 5 to 9 are concerned with the Gaibandha Improvement Project. The remaining six volumes describe supporting studies relevant both to regional planning and the project preparation studies.

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THE REGIONAL PLAN

SUMMARY

1.1 Flooding and Drainage in the Region

The North West region (NWR) covers 3.5 million hectares (Figure 1), and has a population of 25 million people. It shows considerable variation, in relation to such aspects as climate, topography and water resources. These variations are reflected in the range of flooding problems existing within it.

The region has been divided into fifteen planning units in order to provide comprehensive coverage of these problems. Within each unit the flooding situation was assessed by a combination of field visits, primary data collection and analysis of secondary sources. The principle data used related to agricultural cropping, crop and infrastructure damage due to flooding, and water bodies and fisheries.This was supplemented by analysis of hydrological data and the development and use of a hydrodynamic model covering part of the region.

The east and south of the region is bordered by the major rivers, the Brahmaputra and the Ganges. The part of the region along the Brahmaputra suffers particularly severely from flooding caused by breaches in the main Brahmaputra Right Embankment (BRE). This type of flooding is very damaging in the disruption it causes to people's lives, and the losses to agriculture and infrastructure. Similar problems of a more limited scale occur along the Teesta, Dharla and Dudhkumar in the north east of the region. In the south, breaches from the Ganges are not a major source of flooding.

Within the region, flooding and drainage problems are mainly caused by the drainage patterns of the internal rivers. The majority of these drain to the south east to the Lower Atrai/Lower Bangali system, and thence to the Brahmaputra through the Hurasagar outfall. Outfall conditions are often constrained during the monsoon by high levels in the Brahmaputra, and this in turn results in backing up and extensive flooding throughout the Lower Atrai and Lower Bangali. Flooding over three metres regularly occurs over many parts of the Lower Atrai. However, while such flooding constrains agricultural production, it is not a problem in the same way as that caused by breaches from the major rivers since it develops more slowly and does not cause the same amount of social disruption.

The upper reaches of the region are steeper than elsewhere and are susceptible mainly to flash flooding. In most cases the floods last only for a few days and do not cause a great deal of damage to crops, though they can do to infrastructure.

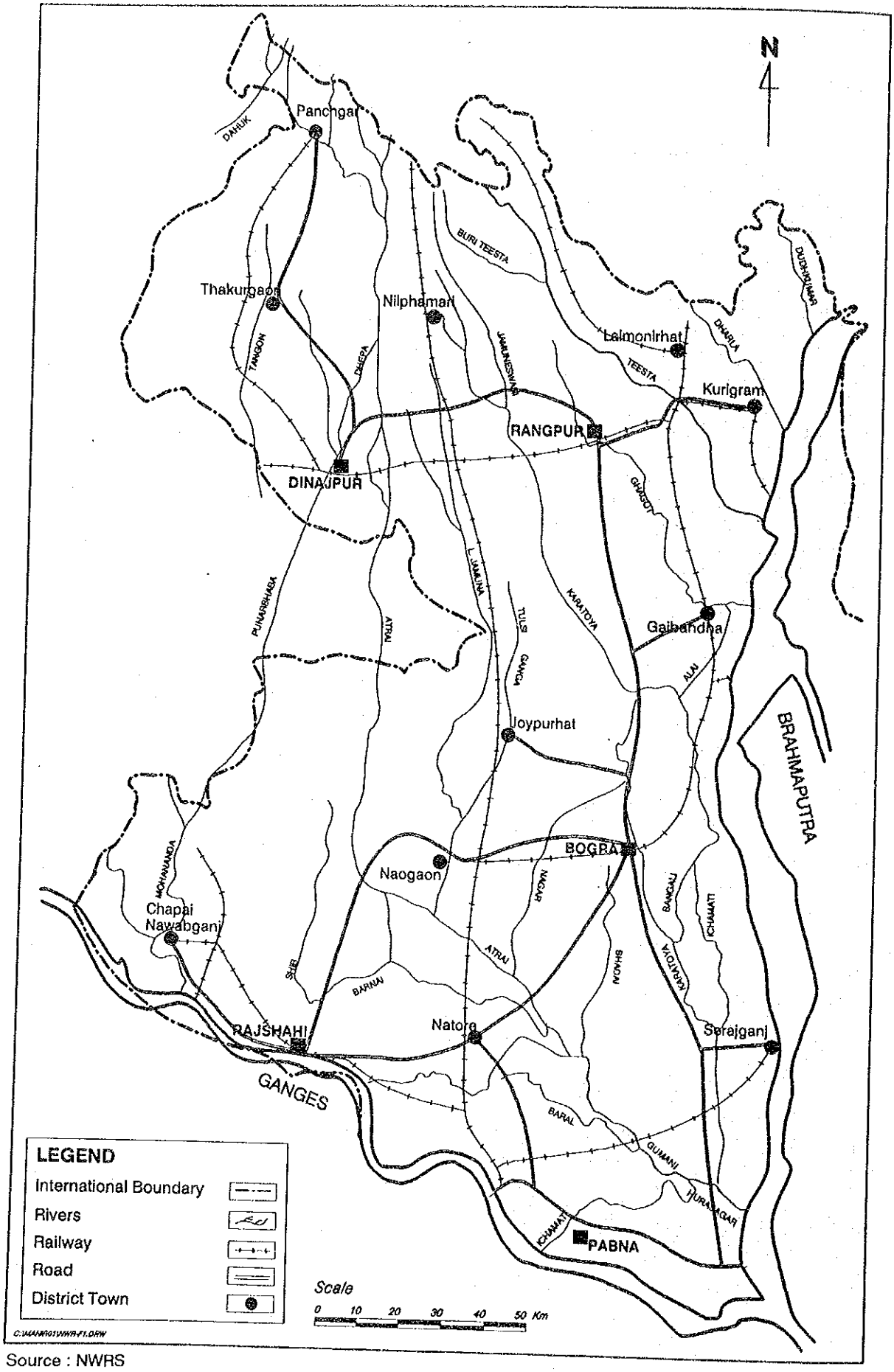
1.2 Approach to Planning

Planning for the region has been based on a number of broad principles. The main objective has been to create a stable flooding regime which gives local people the ability to plan their lives with some degree of confidence and which allows them control of the local natural resources. A second aim has been to create a sustainable pattern of development, which balances the requirements of agriculture, fisheries, navigation, groundwater and the environment. The third aim has been to safeguard lives and property to the extent possible at the time of major floods.

Within these broad objectives a number of other principles have been applied. The most significant feature of flood protection measures is the impacts that they have on adjacent and downstream areas.

Figure 1

The North West Region



Source : NWRS

Generally flood control in one area will lead to increased water depths or discharges and consequent disbenefits elsewhere. In extreme cases this leads to the cutting of flood control embankments by people, in an attempt to reduce level differences between the protected and unprotected areas. Such "public cutting" is widespread through the region. It causes significant loss and damage and is an important source of social conflict and tensions. For this reason a major policy adopted has been to avoid, as far as possible, any plans which would result in significant disbenefits downstream or elsewhere. While it is not possible to apply this principle always, it meant, for example, that structural measures have generally not been recommended in the upstream reaches, since this would have the effect of increasing discharges and flooding in the downstream reaches, where serious problems already exist.

Experience of previous developments indicates that small-scale schemes often perform better than larger ones, because they can be implemented more quickly and local people can more easily be involved in their management. Thus emphasis was put on small-scale schemes; however, these must take place within a regional or sub-regional context which tries to ensure, as far as possible,that disbenefits do not occur elsewhere.

Flood control and drainage (FCD) schemes are extensive throughout most of the region, and there are many existing and on-going projects. Considerable efforts have been applied to integrating the planning with these existing developments where appropriate, and to making the best possible use of existing infrastructure.

A broad range of responses to flood and drainage problems exist. Structural responses are based on embankments to exclude the water, and drainage channels and structures to drain it rapidly. Within the general policies of the Flood Action Plan (FAP) structural measures are intended to provide controlled flooding and drainage (CFD) facilities to the protected areas, which will allow the beneficial use of flood water for agriculture, fisheries, navigation and the environment, but exclude the damaging major floods. In parts of the region a modified approach needs to be applied, which provides partial protection only. This is intended to provide sufficient protection for the harvesting of the important dry season irrigated rice crop (boro) and perhaps for the transplanting of the deep water monsoon crop in the early part of the monsoon, but to allow flooding over the protected area at the peak of the monsoon. Partial protection, particularly in the Lower Atrai, reduces disbenefits to adjacent areas and allows a more predictable and stable flooding regime, than an attempt to completely exclude the peak floods.

Within the FAP efforts are being made to introduce the concepts of compartmentalisation, in which protected areas are sub-divided into smaller units provided with structures and facilities which will give local people control of flood and water resources. This concept has considerable long-term potential within Bangladesh but a great deal of work needs to be done to develop it within the socio-economic context of the country. In planning for NWR, compartmentalisation has been used to mean the provision of facilities which, as far as possible, eliminate cross-drainage basin water transfer,and therefore reduce volumes and discharges of floodwater. This is a first step towards more active water management policies but at the same time it reduces the need for close co-operation between different groups of people who may have different water management needs and priorities.

There are a considerable number of non-structural measures which can also be applied to reduce or mitigate flooding problems. These are grouped under the general term "flood proofing" and include such measures as raising important infrastructure on platforms above the expected flood level, instituting flood warning systems, and providing secure stores for emergency relief and grain. Such measures are relevant everywhere but particularly important for unprotected areas. Generally they should be seen as complementary measures to the structural measures discussed above.

1.3 Development Scenarios

Development scenarios were formulated for all the major parts of the region.

The Brahmaputra Right Embankment

Analysis shows that the most serious flooding problems occur along the Brahmaputra due to breaches in the Brahmaputra Right Embankment (BRE). It also shows that most of these problems can be eliminated, if it can be effectively sealed. Sealing of the BRE is therefore the priority measure for the region. This is the responsibility of the FAP1 project: studies are on-going and priority works at key locations are in hand. Long-term planning for the NWR has assumed that the Brahmaputra Right Bank can be effectively sealed by a combination of heavy engineering works or strategic bank retirement.

Upper Karatoya/Middle Bangali System

The Upper Karatoya basin is subject to extensive flooding at its downstream end where it joins the Bangali system. Proposals for this area include CFD works along both banks of the river. However, in keeping with the principle that upstream works should not lead to increased disbenefits downstream, these developments are associated with a major drain, the "Bangali Floodway", which connects the Upper Karatoya to the Brahmaputra, and diverts all flows apart from a residual flow to the main river. Thus the increased discharges due to the CFD works on the Upper Karatoya are not transferred downstream.

The most important measure in the Middle Bangali System is sealing of the BRE (as described above). If this can be successfully accomplished major projects to reduce flooding conditions are not needed, though there is potential for some drainage improvements, together with measures to improve dry-season water management. In addition, consideration has been given to providing a "second line of defence" against flooding if the BRE itself fails. Three possibilities have been examined but it is recommended that any available investment should be concentrated on the BRE itself rather than put into structural measures for a second line of defence. Flood proofing in the areas susceptible to damage from BRE breaches is an important associated measure.

The Lower Atrai/Lower Bangali System

Extensive development of FCD works have taken place in the Lower Atrai. On the whole these have not performed as well as expected due to problems of increased water levels, public cutting and consequent damage. Full protection along the Lower Atrai is now considered an infeasible solution. A number of alternatives were investigated to try to improve the situation, including major drains which would divert water entering the Lower Atrai and channel it to the main rivers, thus considerably reducing the water entering the Lower Atrai. These were found to be infeasible. An alternative engineering solution suggested was a large regulator at the Hurasagar outfall: however, since the problem at the outfall is the constraint set by the outfall level in the Brahmaputra, rather than backflow from the Brahmaputra to the Atrai, this structure would not be effective.

The main scenario examined for the Atrai has been the "Green River". In this, partial protection only is provided near the Atrai itself, so that at peak monsoon water flows over the floodplain, as it would have done in its natural state. Away from the river the existing infrastructure is utilised as far as possible to provide CFD facilities. The Green River scenario is intended to stabilise the existing

situation so that local people can plan their lives accordingly; it enables considerable agricultural production to take place, while at the same time reducing the disbenefits due to confinement, facilitates floodplain fisheries and navigation and reduces adverse environmental impacts. Within the broad "Green River" scenario, a number of variations were analysed.

Teesta Basin Development

Breaches from the river Teesta cause similar problems to those along the Brahmaputra but on a smaller scale. The main development scenarios involve repairing and sealing the Teesta embankments, which already exist along both side of the river for most of its length. Drainage lines are from north to south so that the impacts of breaches on the left bank are relatively limited in extent. On the right bank, natural slopes mean that flooding from breaches can have effects far downstream.

The first component of work on the Teesta is the Gaibandha Improvement Project, for which a feasibility study was carried out as part of the North West Regional Study. The project comprises sealing of the Teesta right embankment, together with improvements to the internal rivers and compartmentalisation within the project area. The plan involves altering the configuration of the confluence of the Ghagot and Brahmaputra in order to discharge flows from the internal rivers to the Brahmaputra as far upstream as possible. This has benefits not only for the Gaibandha Project area but also downstream.

Other Areas

A limited number of proposals in other areas were investigated. This is in keeping with the general policy of not exacerbating downstream problems by further developments upstream, where flooding problems are in general not so acute anyway. On-going projects are in hand by others in the Kurigram area in the NE of the region, in Pabna, Baral, and Rajshahi in the south of the region, and there are numerous much smaller on-going developments. NWRS prepared proposals for the right bank of the Little Jamuna, where fairly extensive flood damage problems are known to exist, and for the right bank of the Mohananda.

1.4 Benefits

The main economic benefits of flood protection works are derived from agricultural production, and avoidance of crop and infrastructure damage. Cropping benefits derive primarily from a transition from the broadcast monsoon rice crop (b.aman) to a transplanted monsoon rice crop (t.aman), which needs much lower depths of flooding to be successfully grown, and to replacement of local by HYV t. aman. If the change from b.aman to t.aman can be successfully accomplished, financial and economic returns are high. In the NWR, the rivers rise relatively late at the start of the monsoon, after the boro crop has been harvested. This means that there are generally not significant benefits to flood protection works related to the protection of boro. Crop damage due to flooding occurs to both aman crops and is significant throughout the south and east of the region, particularly along the main rivers. Benefits to CFD works from avoiding this damage are significant.

The economic benefits to agriculture are offset by disbenefits to fisheries. However there are two components to the fisheries. Culture fisheries should generally benefit from CFD works, since it provides a more stable flooding regime and prevents losses. This is not normally sufficient to compensate for losses of capture fisheries on the flood-plains, which may be caused by blockage of

fish migration routes between the rivers and the flood-plain. (There are, of course, other factors contributing to losses of flood-plain fisheries, notably over-population and overfishing).

Bank protection works along the main river banks are expensive because of the erosive nature of the rivers. In economic terms such projects may be marginal unless there are specific factors operating, such as the protection of urban infrastructure. Their social benefits are, however, considerable. CFD works within the region, by contrast, are relatively cheap, since they normally involve the rehabilitation or modification of existing facilities. This is particularly the case along the Lower Atrai. Returns to CFD projects can therefore be high.

Economic returns are very sensitive to the returns to agricultural production, and particularly to changes in the monsoon rice crop. Fisheries disbenefits are considerably less in economic terms (around 20-30% of agricultural returns) but depend on the area proposed for the development and the characteristic of the intervention works. Returns are not particularly sensitive to project costs. This means that plan and project appraisal needs to pay particular attention to forecast changes in rice cropped areas (it is assumed that CFD development will not cause changes in yields) and to rice prices.

Cost are naturally an important factor. Judgements are necessary, for example as to the relative merit of river training works against probable recurrent retirement of embankments. Not only are direct costs important (i.e. new land costs, new embankment costs) but social benefits need to be considered.

1.5 Impacts

Besides economic benefits, there are a number of important social and environmental impacts.

The social benefits of protective works along the main rivers are considerable. River erosion causes loss of land, displacement of population, and loss of social cohesion, as well as putting a strain on scarce local relief resources. Even for those who do not lose their lands to the major rivers, breaches through the main embankments are very damaging, disrupting living patterns, damaging crops and infrastructure and preventing development.

On the inland rivers, social benefits from flood protection are more mixed. Since the flooding takes place more slowly it is easier to adapt living patterns to it, and social disruption does not take place on the same scale. Moreover, successful CFD works tend to increase agricultural production, so that benefits go to those who already own land. (The benefits in increased employment for the landless, both during construction and thereafter for agriculture are, however, considerable.) Changes to fisheries also have important social consequences. Culture fisheries tend to increase, thus benefiting those who own the land on which it takes place. Capture fisheries tend to decrease, thus reducing access for poor and landless people to common property resources and an important source of nutrition.

There is evidence that health patterns may potentially be affected by CFD works, with attendant social consequences. However the situation is complex because of the inter-related factors of poverty and population pressure.

CFD works have a number of impacts on the bio-physical environment. The most important relate to bio-diversity, flood-plain fertility, the wetlands, groundwater, and morphology. All these impacts are significant and need to be appropriately taken into account during planning. However, in the case of bio-diversity, flood-plain fertility, and the wetlands, it should be borne in mind that CFD works

are only part of a complete system which is putting great strain on these resources. The key impact on bio-diversity is the increasing reliance on HVY rices, but this is as much the result of irrigated boro cropping as CFD: indeed there is some evidence that bio-diversity increases on higher flood-free lands which support a variety of plant and animal species, and to that extent CFD may have a positive impact. The wetlands and water bodies have considerably reduced in extent over the last two decades but this is also due to pumping for dry season irrigation as much as to CFD works. The key role for the wetlands now lies in the part they play in fishing systems. Fisheries initiatives related to the regional plan are discussed in Section 6.

There is evidence that flood-plain fertility is increased by the fixing of nitrogen through blue-green algae which accompany extensive flooding. On balance, while this is a significant factor, it would not seem to be of over-riding importance in making decisions about implementing CFD measures.

Analysis carried out during NWRS indicates that the impact of possible works on the groundwater resource may be of significance but is also not of over-riding importance. The groundwater resource is generally fairly abundant throughout the NW and potential recharge is high. There are areas where constraints to groundwater development occur: these need to be judged on an individual basis.

Possible morphological impacts on internal rivers are significant but similar in degree to those already experienced within the region. However, if the pattern of damage and disruption from major river flooding is repeated throughout the country, an extensive programme of sealing major river embankments may result. The long-term morphological implications of such a programme need careful consideration at the national level.

1.6 The Regional Plan

Structural Measures

The main components of the regional plan are shown in Figure 2. They include the following:

- sealing of the BRE to the extent possible, under the FAP1 programme. An associated programme of flood proofing should be carried out in areas particularly susceptible to damage from breaches through the BRE. Developments behind the BRE related to the "second line of defence" should await the result of the Compartmentalisation Pilot Project at Sirajganj.

- the implementation of the Green River strategy in the Lower Atrai, to provide partial flood protection close to the river and full CFD facilities in upland areas. This would take the form of a sub-regional development plan, together with a feasibility study for the stabilisation and improvement of Chalan Beel Polders C and D (Polder 2 is under redesign this year through another project).

- development of the Teesta Right Bank, initially in association with the Gaibandha Improvement Project;

- development of flood protection and drainage measures by others in other areas, notably Kurigram South under JICA funds, Bogra Polder 2 redesign under EIP and improvement of Gazaria-Ichamati under SRP.

- flood proofing and protection of towns and other infrastructure in the upstream reaches.

- other schemes show lower returns but could be considered for development in the long-term. These include developments on the right bank of the Mohananda, and of the Upper Karatoya/Bangali Floodway.

The major drains and the Hurasagar Tail Regulator were found to be non-viable and are not recommended for inclusion within the regional plan.

Tables 1 and 2 summarise the main details of each possible component of the plan and ranks them into four broad categories. Economic returns are high for Green River developments in the Lower Atrai and for the small development on the right bank of the Little Jamuna. They are marginal for the Gaibandha Improvement Project and the Teesta Left Bank. Returns are low for the other major developments considered. Social and environmental impacts are generally shown as negative but are not of such magnitude as to necessitate rejection of the proposals. In the case of sealing the major embankments, social impacts are entirely positive. However, as noted above, the long-term morphological impacts in the main rivers if a widespread programme of major river embankment sealing takes place needs to be studied.

Associated Development

A programme of associated development is recommended for implementation with the plan. This includes:

- a programme to mitigate capture fisheries losses;

- programmes for the development of navigation facilities;

- programmes to mitigate adverse impacts on health status;

- a programme of flood proofing, particularly behind the BRE, on the unprotected lands in the main rivers (the chars), and in the upper reaches where major CFD interventions are not recommended.

Consideration must be given to tying the associated development programmes to structural intervention under FAP in order to ensure that sufficient emphasis is given to them by the other agencies involved.

Plan Implementation

The schedule for implementation of the plan is shown in Figure 3. This divides into short-term, priority works, plans for the medium-term and possible developments in the long-term. Priorities have been determined on the basis of needs, economic returns, and the objective of achieving balanced development throughout the region where flooding takes place. A summary of the financing requirements for the plan is given in Table 3, which also gives financing requirements for other on-going and proposed water developments in the region.

Figure 2

Regional Development

The map shows the short-term, medium-term and long-term measures proposed for incorporation within the regional development plan. Short-term measures (5 years) are concentrated in the south and east, where the most serious flooding occurs. Medium-term measures (5-15 years) would include further restructuring projects in the Green River, following priority works in polders C and D. Long term measures are potential projects beyond 15 years.

SHORT TERM PROJECTS

- Priority Works
- FAP Plans
- Other Developments

MEDIUM TERM PROJECTS

LONG TERM PROJECTS

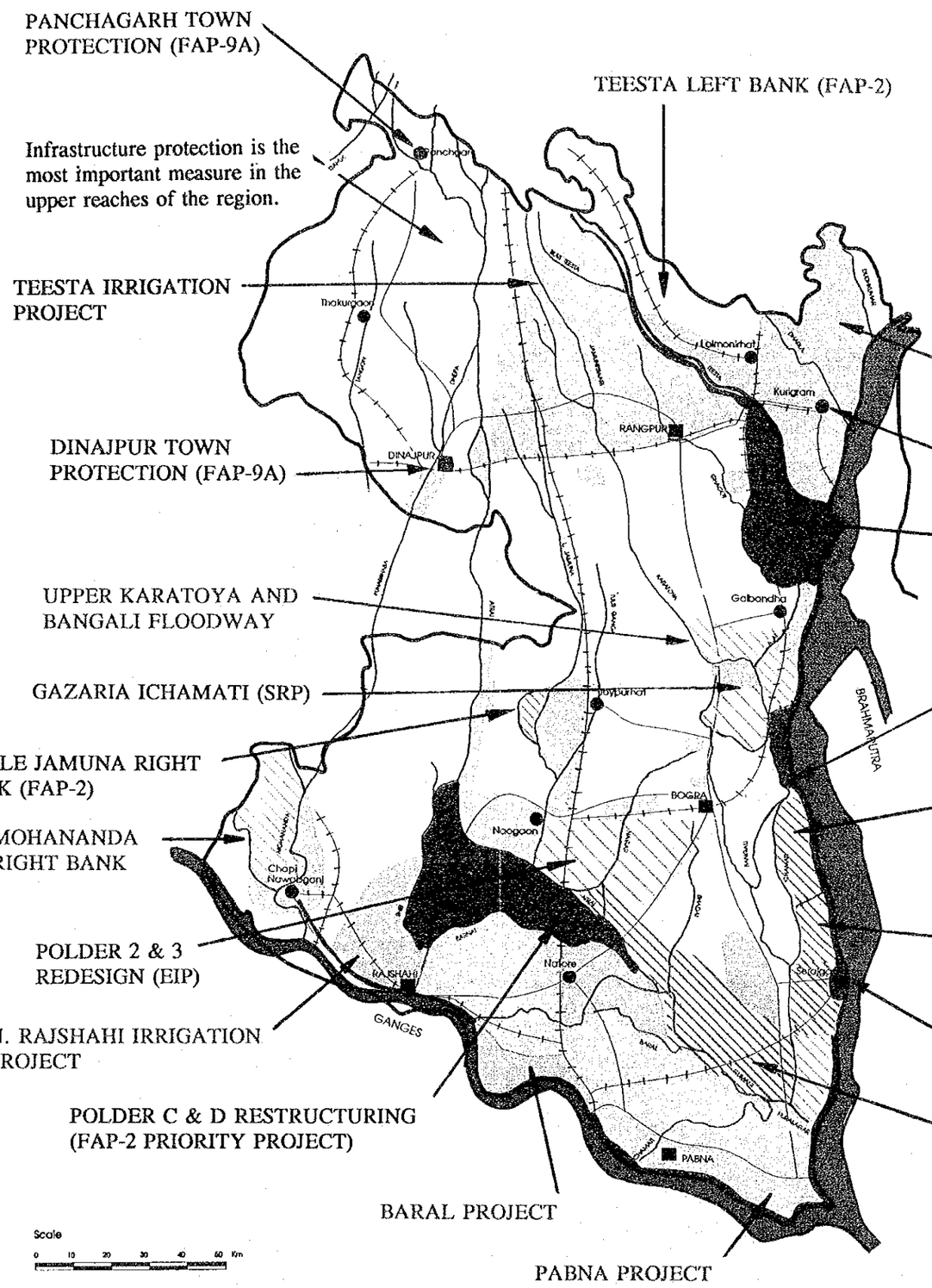
EXISTING AND ON-GOING DEVELOPMENT

N

ASSOCIATED DEVELOPMENT

Important measures associated with the plan would include:

- flood proofing (on the charlands, along BRE, and in the Green River
- fisheries mitigation and enhancement
- navigation infrastructure
- environmental protection & monitoring
- improved O & M



PANCHAGARH TOWN PROTECTION (FAP-9A)

Infrastructure protection is the most important measure in the upper reaches of the region.

TEESTA LEFT BANK (FAP-2)

TEESTA IRRIGATION PROJECT

DINAJPUR TOWN PROTECTION (FAP-9A)

UPPER KARATOYA AND BANGALI FLOODWAY

GAZARIA ICHAMATI (SRP)

LITTLE JAMUNA RIGHT BANK (FAP-2)

MOHANANDA RIGHT BANK

POLDER 2 & 3 REDESIGN (EIP)

N. RAJSHAHI IRRIGATION PROJECT

POLDER C & D RESTRUCTURING (FAP-2 PRIORITY PROJECT)

BARAL PROJECT

PABNA PROJECT

KURIGRAM PROJECTS (JICA)

KURIGRAM TOWN PROTECTION (FAP-9A)

GAIBANDHA IMPROVEMENT PROJECT (FAP-2 PRIORITY PROJECT)
Sealing of the Teesta in connection with the Gaibandha Improvement Project will benefit 200000ha downstream

FAP-1 PRIORITY WORKS
Prevention of breakthrough to the Bangali

SEALING OF BRE (FAP-1)
This is the essential measure for the middle Karotya Bangali basin, Flood proofing is an important measure in the interim period. FAP-21/22 work on bank protection and river training is also important.

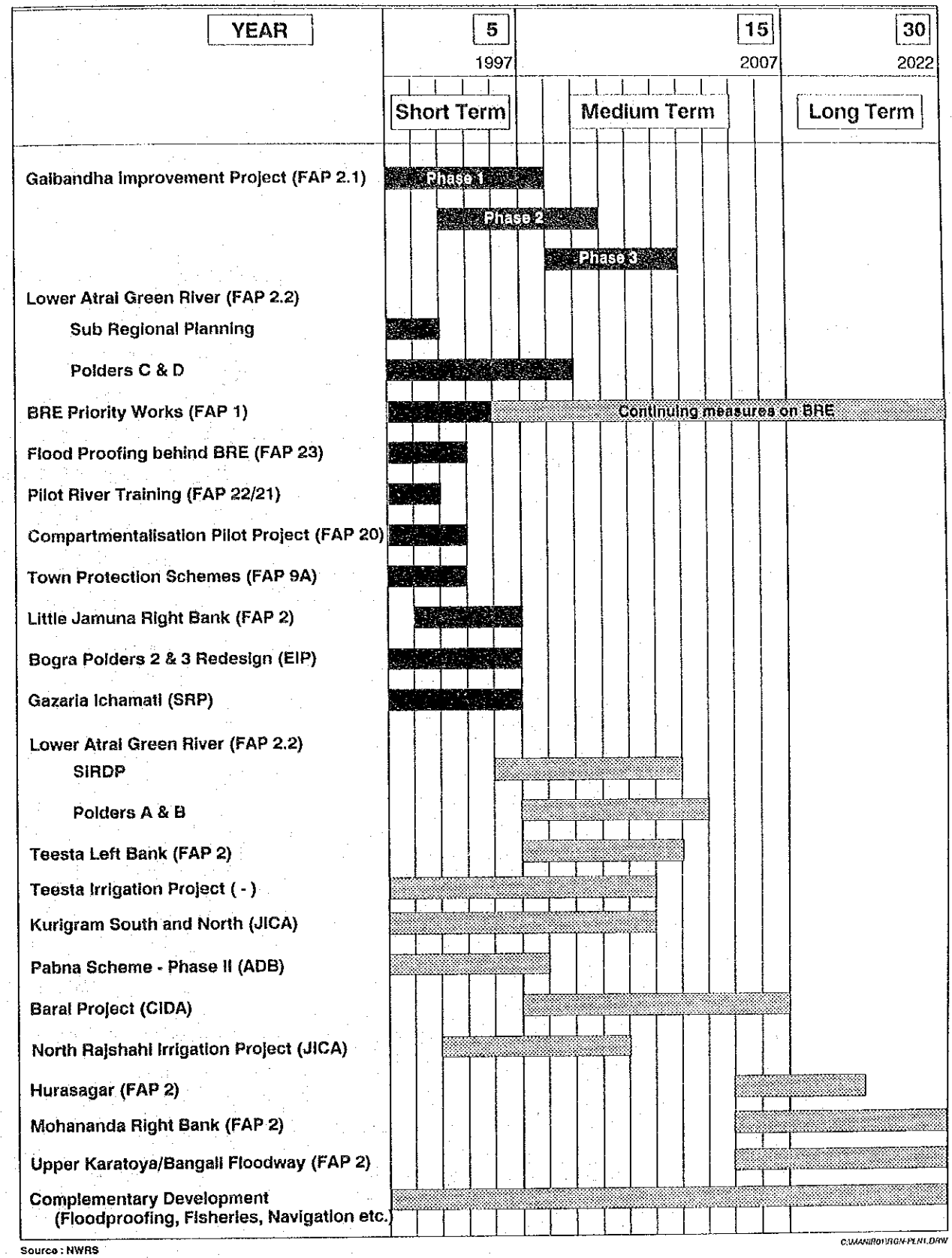
FAP-20 COMPARTMENTALISATION PILOT PROJECT

FAP-1 PRIORITY WORKS
Protection of Serajganj

THE GREEN RIVER CONCEPT (FAP-2)
This aims to provide protection for early monsoon crops but to allow overbank flooding at peak monsoon, thus ensuring a stable and predictable flooding regime with benefits to agriculture, fisheries, and the environment. Restructuring polders C and D is the first component of the Green River.

Figure 3

The Regional Plan



Source : NWRS

Important issues remain to be addressed in relation to which also gives financing requirements for other on-going and proposed water resource developments in the region the implementation of the plan. These include:

- the relationship between recommended elements of this plan, and the work being done by other projects in the region;
- the balance between public and private involvement in implementation, and the need for public participation to the greatest extent possible;
- the need to ensure that implementation schedules are realistic and that they are achieved.
- the problems of standards of construction, particularly relating to earthworks;
- the problems of effective operation and maintenance of completed facilities. Two aspects of this need attention:
  - (a) problems of maintaining main river embankments against erosion;
  - (b) problems of involving local people in O&M and in achieving the necessary social cohesion for effective O&M.

1.7 Future Action

Two priority projects should follow directly from the North West Regional Study (FAP2). These are implementation of the Gaibandha Improvement Project (FAP2.1) and Sub-Regional Planning and Feasibility Studies for Priority Projects in the Lower Atrai (FAP2.2).

The implementation of the Gaibandha Improvement Project involves an intensive period of further planning and detailed design leading to a programme of river training works, CFD and areal development. This is described in the accompanying Final Report for the project.

Work in the Lower Atrai involves a feasibility study for the restructuring of Polders C and D together with sub-regional planning involving as least the following :

- further development of the sub-regional hydrodynamic model used by NWRS, as a planning tool;
- a continuing programme of public consultation concering possible development;
- liaison with FAP16 on wetlands needs assessment and FAP17 on fisheries development in the lower Atrai;
- co-ordination with other programmes working in the Lower Atrai, notably EIP on the redesign of Bogra Polder 2.

Terms of Reference for FAP2.1 and FAP2.2 should be prepared as soon as possible, with a view to commencement in late 1993.

Table 1 Scenario Summary and Ranking Analysis - NW Region

	Lower Atrai Full FCD	Lower Atrai Major drain	Lower Atrai Gr. River	Up. Karatoya (Bangali F.way)	Gaibandha (incl. Teesta RB)	Teesta LB (B'water Embkt)	L. Jamuna R. Bank	Mohananda 20 Year
Net Cultivable Area(ha)	382756	382756	355692	(180000)	(197780)	51021	9500	15073
Total Cost (Tk '000)	4161000	16023000	1498010	2182147	1670080	452397	33584	159418
O&M Cost (Tk '000)	133000	480000	47138	57802	42619	13033	898	4088
IRR(%)	24%	2%	21%	5%	10%	9%	16%	5 %
Ranking Criteria								
NPVR(1)	+1.02	-0.5	+0.42	-0.27	-0.02	-0.06	+0.16	- 0.27
Rice Output (000t)	-	-	1879(+4%)	310(+7%)	335(+8%)	248(+3%)	-	29(+20%)
Total Fish Output(mt)	-	-	19968(-11%)	826(-31%)	675(-3%)	274(-62%)	-	269(-3%)
O&M Cost/ha nca (Tk.)	348	1254	132	(321)	(215)	225	94	271
Const. Empl('000 dyas)	-	-	10035	30360	9760	4280	290	1300
Ag. Empl ('000 days)	-	-	99149(+4%)	19016(+5%)	20037(+6%)	15530(+2%)	-	2191(+8%)
Land Acquisition-ha	-	-	601	3421	425	293	30	166
Biophysical Impacts	-2	-3	-1	-2	0	0	-1	0
Social Conflict	-5	-2	+3	+1	0	+2	0	+1
Inst. Complexity	-2	-3	-1	-3	+1	-1	+2	0
Hazard	-5	-2	0	-1	0	0	+1	0
External Impacts	-3	-3	0	0	+2	0	0	0
OVERALL RANKING	N	N	1	3	1	2	1	3

Source: NWRS estimates

Notes:

1. Impacts range from +5 (very positive) to -5 (very negative)
2. Overall ranking: 1-high priority, 2-medium priority, 3-low priority, N-not recommended
3. Economic indicators for Lower Atrai full FCD and Major Drains based on analysis in Interim Report.
   Some ranking criteria for these scenarios are excluded since they were calculated on different basis from 1992 analyses.

Table 2 Project Summary and Ranking Analysis – Lower Atrai

	Polder 2 Gr. River	Polder 3 Gr. River	SIRDP Gr. River	Hurasagar S Gr. River	Polder A Gr. River	Polder B Gr. River	Polder C Gr. River	Polder D Gr.Riv	Hurasagar N CFD	Hurasagar S CFD
Net Cultivable Area(ha)	52089	55578	64275	6225	27716	29411	42498	52650	25250	6225
Total Cost (Tk '000)	223589	98270	153704	63145	159171	162901	163184	239466	226281	86804
O&M Cost (Tk '000)	6156	2770	9115	1958	4622	4565	4431	7115	6456	2265
IRR(%)										
Ranking Criteria	24%	21%	35%	7%	14%	19%	15%	17%	- ve	21%
NPVR(1)	+0.8	+0.55	+1.61	-0.23	+ 0.1	+ 0.45	+ 0.15	+ 0.29	-0.58	+0.74
Rice Output (000t)	283(+6%)	340(+3%)	228(+2%)	29(+5%)	122(+4%)	148(+13%)	193(+5%)	221(+12%)	120(+4%)	35(+30%)
Total Fish Output(mt)	1587(-14%)	1636(+25%)	4137(+5%)	387(+2%)	1037(+18%)	833(-30%)	2020(-6%)	1774(-42%)	341(-3%)	229(-40%)
O&M Cost/ha nca (Tk.)	109	49	68	315	169	155	98	133	256	264
Const. Empl('000 dyas)	1558	637	1340	500	1490	1390	1280	2340	2080	510
Ag. Empl ('000 days)	13453(-7%)	15975(+1%)	12978(+1%)	1657(+3%)	6625(+3%)	8914(+8%)	10645(+4%)	12989(+8%)	7132(+4%)	2242(+40%)
Land Acquisition(ha)	108	35	77	13	55	84	76	130	23	13
Biophysical Impacts	-1	-1	-2	-1	-1	-1	-1	-1	-1	-3
Social Conflicts	+3	+3	+3	0	+1	+1	+3	+3	-1	0
Inst. Complexity	-1	-1	-1	-1	-1	-1	-1	-1	0	0
Hazard	+1	+1	+1	0	0	0	0	0	-1	-3
External Impacts	0	0	0	0	0	0	+2	+2	-1	0
OVERALL RANKING	1	2	2	N	2	2	1	1	N	3

Source: NWRS

Notes:

1. Impacts range from +5 (very positive) to -5 (very negative)
2. Overall ranking: 1-high priority, 2-medium priority, 3-low priority, N-not recommended

Table 3 NW Region: Financial Requirements of the Short and Medium Term Plans (Tk. million)

Name of the project	Years														
	Short Term					Medium Term									
	92-93	93-94	94-95	95-96	96-97	97-98	98-99	99-2000	00-01	01-02	02-03	03-04	04-05	05-06	Total
A. ONGOING BWDB PROJECTS	1062.93	1758.55	1529.01	1543.50	1800.00	1800.00	1200.00	842.80							11536.79
B. PROPOSED BWDB PROJECTS	19.7	473	876.8	1186.1	2051	2391	1139	736	427	36					9335.6
C. PROPOSED FAP PROJECTS (Excluding FAP2)	194	1033	965	1032	539.8	723.7	716.7	677.8	600	600	600	600	600	600	9482.0
D. FAP-2 PROJECTS															
Gaibandha		41.7	54.4	218.1	399.8	470.2	230.5	91.3	35.6	41.7	60.3	26.5			1670.1
Sub Reg Plan		50	50												100.0
Polder C&D		20.2	20.2	20.2	51.6	120.4	137.6	34.4							404.6
Little Jamuna R B		3.4	9.1	15.1	6										33.6
Polder 3					9.8	13.3	31	35.4	8.8						98.3
SIRDP						7.7	7.7	7.7	21.9	51.2	58.5	14.6			169.3
Polder A&B							16.2	16.2	16.2	41.3	96.4	110.2	27.5		324.0
Teesta Left Bank							22.6	22.6	22.6	64.5	150.4	171.9	43		497.6
Flood Proofing		20	20	20	20	20									100.0
Environmental Management Plan		10	10	10											30.0
Sub-Total (FAP2)		145.3	163.7	283.4	487.2	631.6	445.6	207.6	105.1	198.7	365.6	323.2	70.5	0	3427.5
TOTAL	1277	3410	3535	4045	4878	5546	3501	2464	1132	835	966	923	671	600	33781.9

Source: Consultant's Estimates and BWDB.

Notes:

1. Costs of compartmentalisation in NWR has been assumed as the same as the ongoing project at Tangail.
2. In the absence of estimated cost, parametric cost has been assumed for some projects.
3. Estimates for flood proofing and the Environmental Management Plan are for initial programmes only. Future Expenditures would be assessed after evaluation.

2.1 The Project Area

The project area lies south of the confluence of the major rivers, the Teesta and the Brahmaputra. It is bounded on its south and west sides by the river Ghagot, and on the far north-west by the Gaibandha to Kaunia railway line (Figure 4). The gross area is 57600 ha.

It has a population of 550000 people, at a density of just under 10 per gross hectare. It is thus more densely-populated than the average for rural Bangladesh. It is a very poor area, with high levels of landlessness, few employment opportunities, low levels of health and literacy and lack of infrastructure provision. Many people who have lost their land to the main rivers live in harsh conditions on the main embankments. Seasonal out-migration in search of work is extremely common.

Agriculture is the main activity in the region. Present cropping intensities are around 170%. The main monsoon crop is transplanted aman. Jute is also important in the area. Irrigation coverage is at present about 30% of the area, predominantly from groundwater.

Fishing takes place in the bordering rivers and in beels within the project area. There are also fish ponds within the area, but these are not as widespread as in some other parts of the north-west region because the porous soils means that the fish ponds are difficult to maintain. Total production at present is estimated at about 750 tonnes, of which 55% is capture fisheries.

Provision of infrastructure such as roads is generally poor. One thana (local government centre) within the area is not connected to a sealed road. Flood protection embankments exist along the Brahmaputra and Teesta, along part of the Ghagot, and downstream of Gaibandha on the Sonail scheme. The embankment along the Teesta, in particular, is breached over a long portion.

With the exception of the limited number of beels within the area, there are no large areas of persistent deep flooding. The land is intensively farmed and the biophysical environment has been modified as a result of this. Groundwater supplies are adequate and there are no serious problems of water quality. Health problems exist; these are contributed to by the poverty and dense population in the area. Navigation is at present not very widespread through the project area, and takes place only during the monsoon.

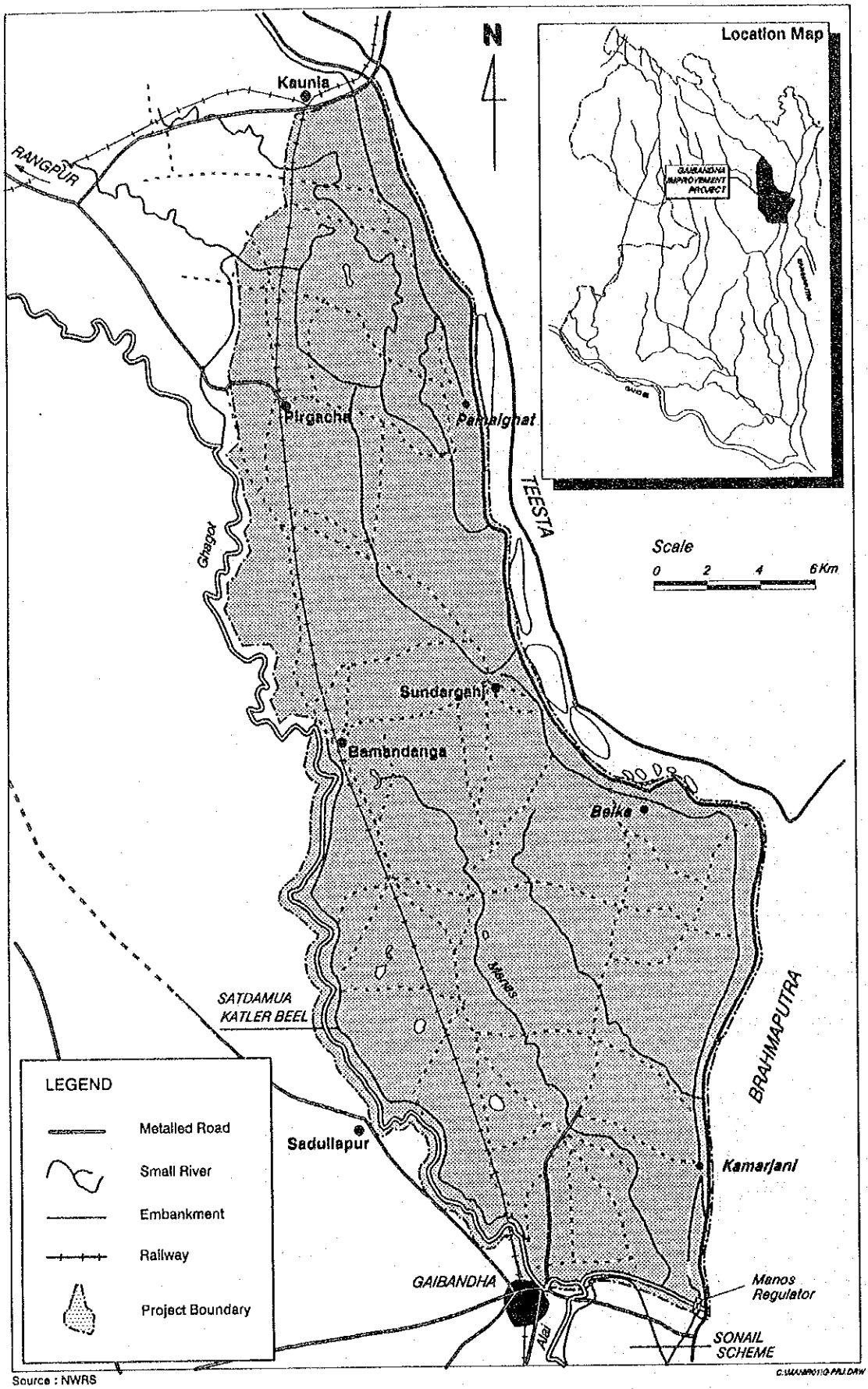
Gaibandha is a district town, and has the appropriate facilities and government structure. There are all or part of five thanas within the areas, each with their own appropriate facilities and local government structure. Several NGOs are working, on a variety of social and income-generating projects.

2.2 Flooding Problems

The flooding problems within the project area are set by the rivers surround it. These relate to flows through breaches in the Teesta right embankment (both within the project area and upstream), spill from the Ghagot left bank, breaches in the BRE, and drainage congestion at the downstream end. Erosion and breaches in the BRE cause serious localised problems but do not have extensive impacts throughout the project area since land slopes mean that drainage is from the project area towards the

Figure 4

Project Area



Source : NWRS

main river. However the Manas regulator which lies at the outfall of the Ghagot to the Brahmaputra is likely to be washed away next year. There is therefore an urgent need to decide on the necessary course of action to take, assuming that this will indeed happen.

A key aspect of flood protection development is that it has significant impacts on adjacent and downstream areas. Therefore additional areas have been considered in formulating the project plan. These include areas on the right bank of the Ghagot which are impacted by left bank developments. Downstream of Gaibandha the Ghagot flows into the Alai. Impacts of project works on floods in the Alai have also been considered.

An extensive round of public consultation was held to elicit the views of the public on flooding problems and possible solutions. These included formal and informal meetings with groups of villagers in different locations, together with interviews with district level officials, and formal meetings with thana officers and local chairmen. Meetings were also held separately with NGOs. These confirmed the general picture of flooding in the project area. A range of options were put forward during the consultation. There is effectively unanimous support for any measures which will control the major rivers in their present courses, prevent breaches and prevent further loss of land. At the downstream end there was also very widespread support for replacement of the Manas Regulator by a different arrangement which would not cause drainage congestion. Cuts regularly take place on the BRE just upstream of the regulator to relieve such congestion. Excavation of the internal rivers such as the Ghagot and the Alai was also suggested on many occasions, as a means of stopping spillage from these rivers. Elsewhere options were often set by local conditions and might be in conflict with options suggested by others in adjacent areas. For instance, those on the right bank of the Ghagot opposite existing the Satdamua-Katler-Beel embankment proposed an embankment on the right to protect them. This would further raise levels along the Ghagot and disadvantage the significant number of people living between the embankments.

2.3 The Range of Options

Following field investigations and the rounds of public consultation, a very wide range of structural options for alleviating the flooding problems were investigated. These covered sealing of the Teesta Right embankment at different locations, different embankment protection schemes along the Ghagot left and right banks and different configurations at the confluence of the Ghagot, Alai and Brahmaputra. Analysis of the impacts of these components, independently or in combination, was carried out using a hydrodynamic model specially developed for the study in order to determine the most favourable combination. Morphological considerations were also taken into account. Following this analysis a further set of refined options were produced, with the preferred set of measures on the main rivers but which differed in their treatment of internal drainage flows. One option left existing drainage patterns unchanged while the other eliminated cross-drainage basin water transfer through a form of compartmentalisation. A further option omitting any drainage regulator at the downstream end of the project area on the BRE was also investigated at this time. These were analysed using a 10 year design simulation of the hydrodynamic model in order to select the preferred option.

Besides structural options a number of technological options were also considered. These included an analysis of the factors affecting the choice between river training works designed to constrain the major rivers in their existing courses against bank retirement which accepts some loss of land to erosion. Another set of options related to methods of construction, and the choice between using a mixture of mechanical and manual methods, part of which would require relatively sophisticated technology which could only be operated by experienced contractors, and systems which rely primarily on labour-intensive methods appropriate to the large numbers of landless and poor people

in the project area. The technological options were analysed separately prior to the formulation of the preferred plan.

In addition to structural and technological options, a variety of other non-structural measures were considered as part of the project. These are discussed in section 8.

2.4 The Base Option

The main components of the project which were carried forward to full analysis are as follows:

- Sealing of the Teesta right embankment both upstream and downstream of Kaunia, to-gether with necessary strengthening of the existing embankment and improvement of structures.
- Retirement and strengthening of the BRE as necessary.
- Removal of the Manas regulator, and the construction of a new regulator at the outfall of the Manas to the Ghagot.
- The construction of a backwater embankment along the Ghagot upstream of its confluence with the Brahmaputra.
- Construction of a regulator at the head of the Alai river.
- An extension of the Ghagot left embankment upstream from Bamandanga as far as the Alai Kumari confluence.
- Compartmentalisation within the GIP area.

These are shown in Figure 5. The total cost for these measures in Tk 1670 million.

2.5 Associated Development

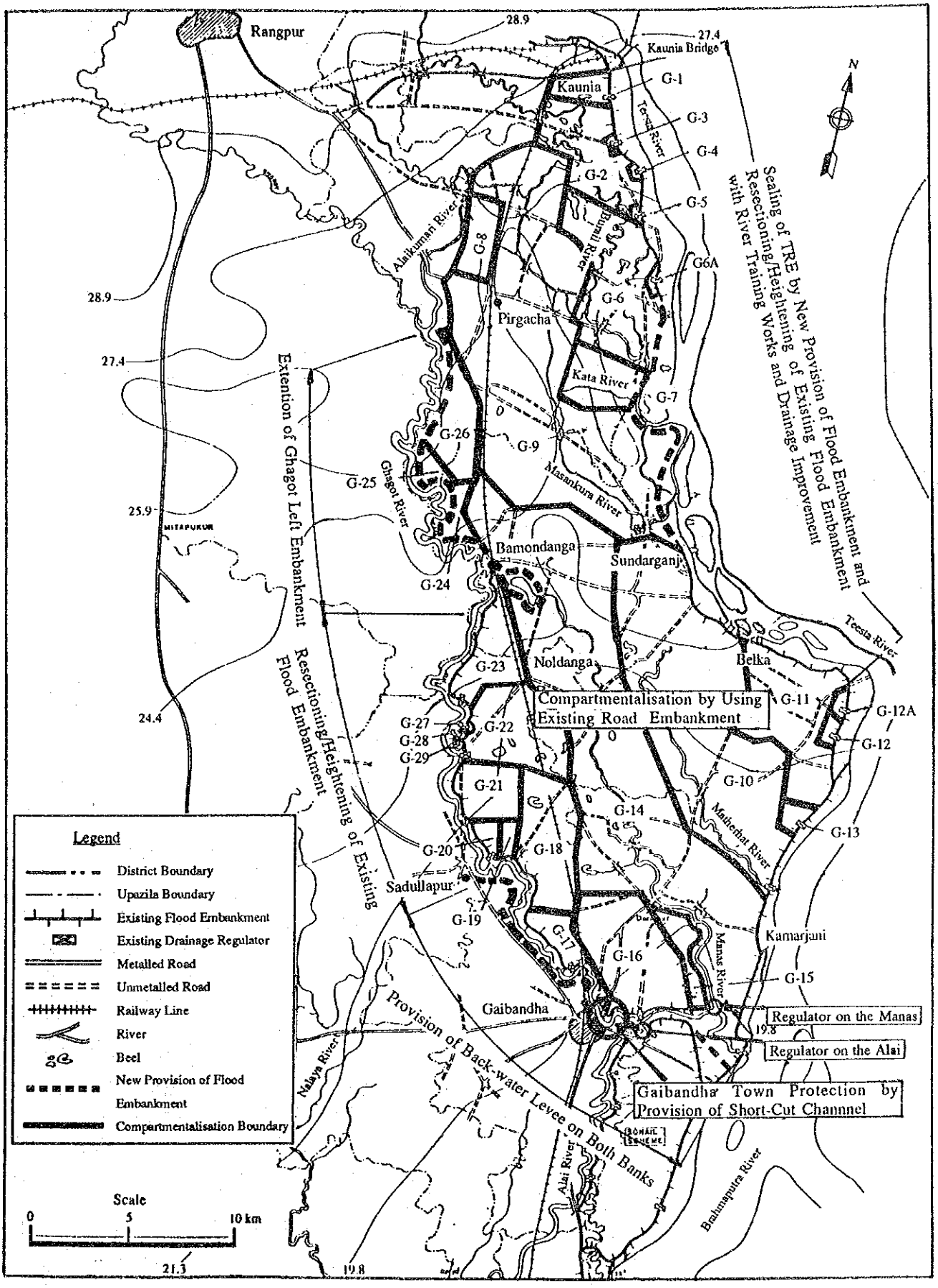
A number of important associated developments should be undertaken at the same time as the main project. These relate to flood proofing, fisheries, navigation, and health.

Flood Proofing

Flood proofing measures are recommended, primarily for those living outside the protected areas and on the chars in the Brahmaputra and Teesta, and also for important public infrastructure within the protected areas. Structural measures include raised platforms for family shelters, complete with sanitary latrine and tubewell, on the chars. On the main river embankments where many displaced families take shelter, there is also a need for sanitary latrines and tubewells. Boats should be provided for emergency transport in the event of high floods. In the protected area it is proposed to provide heightening of some existing village roads, together with flood store-cum-shelters, at three locations.

Figure 5

The Project Plan



Source NWRS

There are also important non-structural measures which can be undertaken in relation to flood-proofing, such as instituting early-warning systems, establishing embankment surveillance groups, creating food and fuel storage facilities and the like. NGOs have an important role to play here: such actions should be linked in with those undertaken on a regional or national scale.

Fisheries

In regard to fisheries, the programme should consist of the following components:

- preservation and improvement of khas water bodies,
- development of borrow-pit fisheries,
- modification of hydraulic structures to allow fish passage to the extent possible,
- enhancement of capture fish resources through public stocking programmes,
- support for fish farming opportunities.

There are other more general actions and programmes which should be undertaken as part of a nation-wide attempt to strengthen the fisheries sector. These include a new water body areas survey, improvement of fisheries statistics collection, enforcement of fisheries rules, strengthening of the extension service, and research into minor carp propagation. In addition the work being carried out into the development of rice/fish culture systems is obviously of great importance to the future of rural production in Bangladesh.

Navigation

Navigation has not recently been of importance in the Gaibandha area. However the project proposals would open a route for traffic from the Brahmaputra into the Ghagot and to Gaibandha. In addition, the advent of cheap and readily accessible engines for country boats has revitalised the sector, and consideration should be given to developing country boat routes inside the project area. Three potential routes have been identified and preliminary proposals outlined. Considerably more work is required, particularly to assess the work required on the internal routes, the trade off between the requirements for navigation, fisheries and perhaps irrigation, and to determine the optimum method of connection or transhipment between the country boats and the main river.

Health

Potential health problems have been identified, due to water-related diseases. The relative contribution to these problems of CFD works and other factors such as poverty and population pressure has not been determined. However, there is a clear need for further studies during the next stage of planning and detailed design, and the incorporation of mitigatory measures if these can be identified. These are likely to relate particularly to flushing and drainage problems, and the avoidance of small stagnant water bodies.

The estimated cost for flood proofing, fisheries and navigation is of the order of Tk 200 million. Health costs are not included, since they are not sufficiently defined.

2.6 Implementation

The implementation schedule for the full project is shown in Figure 6. It breaks the project up into phases, with the more urgent river training works being carried out as soon as possible, and other components which have lower returns (such as the Ghagot left embankment extension), or which need significant further planning and consultation (such as compartmentalisation) being left until later. An overall implementation period of eleven years is allowed, with a considerable period for further planning and detailed design before any physical works starts. This will make it possible to resolve important institutional issues and to begin the establishment of suitable groups of local people for the consultation process, and for involvement in construction and O&M. A programme for the implementation of the associated development is also included in Figure 3.

Institutional issues to be resolved relate to the overall management of the project, and the methods for promoting integration between the various institutions involved, specifically local people, agency representatives, local government and NGOs. The traditional model of a project committee with representatives from all concerned institutions is probably too large to be effective and some thought should be given to a much smaller co-ordinating committee, with key representatives from each sector. A project management unit (PMU) to provide technical support and backup will probably also be required. This could best be provided through a local consultancy group, perhaps with some foreign inputs.

A further institutional aspect to be considered is that there are on-going proposals for developments within the project area which have direct linkages with the proposed project plan; there may also be a need to make immediate decisions on actions to be taken if, as seems likely, the existing Manas regulator is washed away during the next monsoon. Thus some mechanism for co-ordinating on-going work and integrating with project proposals and institutions is needed in the short term. Such on-going or new proposals for work by others within the project area are likely to be a permanent feature of the work and are to be welcomed. The project should be seen as providing an overall sub-regional framework, within which a range of small-scale developments can take place.

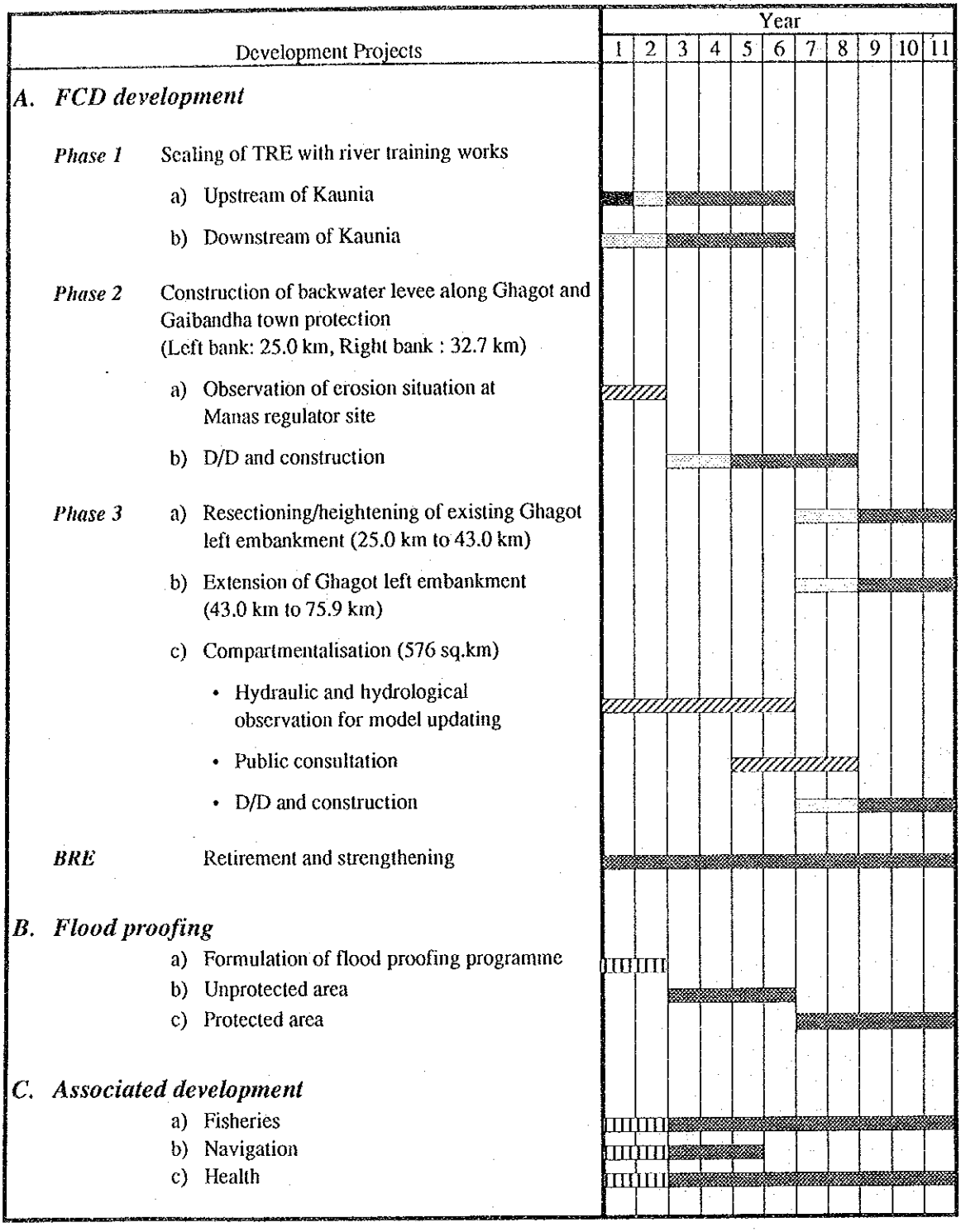
Operation and maintenance continues to be a difficult problem to resolve for flood protection schemes. As the new works will not become operational for some time, there is the opportunity to consider a variety of different approaches, all of which must be based on a much greater degree of public involvement than hitherto. There is a possibility that the next stage of FAP13 could base a pilot project for O&M at Gaibandha, in order to develop new concepts and improved processes. Again, there will be a need for liaison with on-going projects, many of which are part of existing O&M initiatives.

2.7 Project Analysis

Analysis was carried out of the base option and a range of the other structural and technological options which were investigated. The results are given in Table 4.

Figure 6

Implementation Schedule



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

Table - 4 Gaibandha Project Analysis

Total Project Cost (Including sealing of Teesta upstream of Kaunia)	Tk.	1670 million
EIRR of Base Option		10%
Annual Rice Output		335,000 Tones (+8%)
Total Annual in Fish Output		675 Tones (-3 %)
Incremental Construction Employment		9.76 million days
Annual Agricultural Employment		20 million days (+6%)
Reduction in Annual Damage:		
- Crop	Tk.	37 million
- Infrastructure	Tk.	45 million

Sensitivity Analysis	Economic Internal Rate of Return
10% Increase in Rice returns on Base Case	17%
20% Increase in all Costs on Base Case	8%
Base Case with Bank Retirement instead of River Training (15 year)	6%
Base Case with Mechanical/Manual Construction	7%
O&M at 10% for River Training Works	6%

In respect of the technological options, analysis shows that river training works were to be preferred to bank retirement. The economic costs of river training are lower than for bank retirement, even allowing for the high cost of O&M of bank protection, not only because of the high cost of retirement itself but also because of the high cost of loss of productive land to river erosion. In this case the results of the economic analysis would be fully supported by social impact analysis. People living in the area affected by river erosion are unanimous in wishing the bank to be stabilised in its present location and there are no social conflicts involved in attempting to achieve this.

Analysis also shows that economic returns are lower for the mixed mechanical/manual methods of implementation, than for labour-intensive methods. Labour-intensive methods are considerably cheaper; although they take longer and have higher O&M costs, overall they have lower economic costs. They also have considerable advantages in creating employment for poor and landless people, and have greater potential in enabling public participation in the planning, design, and construction of the facilities. This should also have advantages in involving local people in the subsequent O&M. On the other hand, mixed mechanical/manual methods result in a higher standard of construction and better quality facilities. This is important in view of the very low standards, particularly of bank compaction, which are commonly seen.

All subsequent analysis was therefore carried out of options involving river protection rather than bank retirement and labour-intensive rather than mixed mechanical/manual methods of construction.

Economic analysis was carried by comparing the economic costs of the project against its economic benefits. This analysis involves the full range of costs for all the works stated, plus periodic bank retirement of BRE. Benefits consist of increases in agricultural production, reduction in crop and infrastructure damage, and changes in fish production. Besides benefits within the project area, there are benefits outside, notably on the right bank of the Ghagot where flows will be reduced due to sealing of the Teesta upstream, and downstream on the Alai, where flows will be reduced due to the regulator on the Alai. Avoidance of losses due to river erosion by the Teesta has also been included as a project benefit.

The returns for the base option involving all components of the project are 10%. These benefits are fairly low because they are based on fairly low increases in agricultural productivity, (an increase in HYV t. aman over an area of 6362 ha, which is an annual incremental benefit of Tk. 70mm in economic prices). Significant benefits are also obtained from reduction in crop and infrastructure damage, amounting to about Tk. 37 million and Tk. 45 million per annum respectively. These benefits include damage reductions in the impacted area. In addition avoidance of losses due to river erosion is a significant benefit. In net terms there is almost no change in value of fisheries benefits, although there is a decline in capture fisheries and a projected increase in culture fisheries.

As with FAP projects generally, returns are very sensitive to benefits. A 10% increase in overall returns from rice production, which could be made up partly of increased area and partly of higher prices, would increase the EIRR of the base project to about 17%. Returns are much less sensitive to costs. An increase in all costs of 20% only reduces the EIRR of the base case to 8%.

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, however, 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. The proposed phasing of the overall project is also justified by

this analysis, since more study will be required to establish the precise design of compartmentalisation.

2.8 Project Impacts

The social and environmental impacts of the project are generally positive.

Sealing of the Teesta embankment and protection from the major rivers would be welcomed by all who live within their influence: other project measures such as the new configuration of the Ghagot/Alai/Brahmaputra confluence would tend to reduce existing social conflict, for instance downstream on the Alai.

Construction and increased agricultural output will generate employment for landless and poor people.

The rounds of public consultation that have already taken place have engendered a positive sense in the community towards the proposed development. If this can be continued into the detailed design stage, there is the possibility of fostering a genuine spirit of participation from the local people in further stages of planning, design, construction and O&M.

There are some potential social implications to the option of compartmentalisation. While the area of flooding is reduced overall, it is spread more widely than in the "without compartmentalisation" option. This may cause increases in water-related health problems; it may also lead to increased numbers of locations where head differences exist across embankments, so possibly increasing social conflicts and the potential for public cutting. The implementation schedule allows adequate time for analysis and consultation to eliminate such potential problems prior to construction.

The income distributional consequences of the project are likely to be adverse, since those with the largest landholdings gain the greatest benefit. However, the same is true of any projects based on land enhancement. Although the greatest increases in per household incomes are likely to go to larger landowners, significant short-and long-term benefits should also accrue to small farmers and labourers. Other potential benefits will go to fishermen, boatmen and char and embankment dwellers if the proposed associated developments are included in the project.

Adverse impacts on the bio-physical environment are relatively minor. Impacts on fisheries have already been noted: consideration should be given to mitigation measures, as discussed further in Section 5. There are no extensive areas of wetlands within the project area.

The other potentially important impact is on the morphology, not of the project area itself, but of the main rivers. The long-term morphological stability of a strategy which seeks to exclude the major rivers from protected areas,and so retain sediment within the main river channels must be investigated.

2.9 Recommendations

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 full project with all components should go forward to a period of detailed design and associated planning, with a view to implementation over the forthcoming eleven year period. It should be accompanied by the programme of associated developments in fisheries, health, navigation and flood proofing, in order to provide an areal development strategy for the project. The project as formulated has reasonable economic returns and highly positive social impacts. Adverse environmental impacts are relatively minor.

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 pre-design planning, physical 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 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;
- analysis of fisheries, navigation and health aspects for incorporation into the areal development plan.