Government of the People's Republic of Bangladesh

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

BANGLADESH ACTION PLAN FOR FLOOD CONTROL

COMPARTMENTALIZATION PILOT PROJECT (FAP 20)

SIRAJGANJ CPP INTERIM REPORT MAIN VOLUME

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SIRAJGANJ CPP INTERIM REPORT

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i EXECUTIVE SUMMARY

Background

In the (revised) Inception Report (April 1992) a number of observations were made on the suitability of the location of the Sirajganj CPP area. A negative point in the selection of the compartment area directly North of Sirajganj is the instability of the *Brahmaputra* Right Embankment (BRE) in this area. In the last 10 years, especially in 1987 and 1988, several breaches in the main embankment caused unexpected flooding. In other words, since then the BRE has often failed to provide the expected level of protection. As a consequence, the local people have adjusted their farm and non-farm activities accordingly.

A secure main embankment can be seen as one of the pre-conditions for a successful operation in the CPP. However, the strengthening and maintenance of the main embankment is beyond the task of FAP 20. In the ToR it is assumed that measures will be taken to eliminate the hazard of flood damage resulting from breaching of the BRE. The BWDB (O&M) is responsible for the maintenance and for a timely retirement of the embankment. Retirement of the BRE along the *Jamuna* has been completed as reported by the BWDB.

As expressed during the Needs Assessment Survey and the Consultation Process, the people demand the embankment to be stable and secure. As a result the *Sirajganj* CPP faces two problems:

- it will be difficult to evaluate the impact of compartmentalization on the area after completion of FAP 20 project interventions because of an unstable baseline situation and also it will be difficult, if not impossible, to separate the impact of the strengthening of the BRE from that of compartmentalization;
- it will be difficult to ensure people's participation in interventions of compartmentalization (i.e. the water management of the area behind the BRE) as their overriding demand is the strengthening of the BRE. However, as the containment of the BRE breaching is one of the CPP objectives and already included in the development options, people's participation will be enhanced.

These constraints were acknowledged by the FPCO. But as no other - more suitable - area behind the BRE could be identified, it was decided to continue with the *Sirajganj* area.

Sirajganj CPP

The Sirajganj CPP area is part of the *Karatoya-Bangali* floodplain. The area north of CPP drains towards the CPP area through *Ichamati* khal and *Ichamati* River. In the south backwater from *Hurasagar* and *Karatoya* rivers occurs. The compartment belongs mainly to *Sirajganj* Sadar Thana (95%). There are about 50,000 households in the area, of which 15000 farming households and 800 professional fishermen. The total population is

estimated at 292000 of which 132000 in *Sirajganj* town. The total area of the *Sirajganj* CPP is 12057ha, of which a net area of 9579ha is cultivable. The CPP area has been divided into 9 sub compartments, including *Sirajganj* town. A separate map is provided in the back of this report for easy reference.

Objectives

The overall objective of FAP 20 is to establish appropriate water management systems for the development of protected areas so that criteria and principles for design, implementation and operation can be made available for other FAP projects. Specifically this will entail the testing of the compartmentalization concept in the field under real operating conditions, addressing all relevant socio-economic, institutional and environmental issues and trying out water control works and water management systems. This Interim Report will outline how these objectives would be achieved in the *Sirajganj* CPP area.

Planning Procedures

Based on set structural and non-structural targets, the conclusion of the various surveys, the results of modelling, the engineering possibilities and the institutional requirements, the plans and design criteria have been worked out for several development options. In doing so, peoples involvement throughout the planning process was considered essential to ensure the sustainability of the project. This not only applies for the CPP area itself but also to the adjacent areas which might become compartments in the future. By that time interlinkages between adjacent compartments should be clearly defined.

Peoples Participation

In CPP people's participation consists of three phases. Firstly a *Needs Assessment Survey* (NAS) is carried out among different interest groups such as farmers, fishermen, women and landless. The output was used by the planning team to draw up a number of alternative options for development. Secondly, these options are discussed in phases of a *consultation process*. The opinion of the local people and their representatives have been and will be accorded much weight in the decision making process. The third phase is the *institutionalisation*.

Results of the Needs Assessment Survey and Initial Consultations

The people have expressed their interest in such options which include in general terms:

- protection from erosion of the *Jamuna* river bank (many think that more groynes have to be constructed)
- securing or sealing of the BRE (with retired embankments as a last resort),
- sluice gates sufficiently deep and wide at intake points linked to the internal network of channels;

- re excavation of many local *khals* and channels;
- re excavation of the *Ichamati* branch;
- road improvements with necessary bridges and culverts;
- embankment on the left of the *Ichamati* river (with the exception of fishermen and people living on the right bank of the *Ichamati* river); and
- *beels* and khash ponds development for fish cultivation.

Development Options

The following options for development have been selected:

OPTION 1:	COMPARTMENTALIZATION PROJECT SITUATION WITHOUT AN *ICHAMATI* EMBANKMENT
OPTION 2A:	COMPARTMENTALIZATION PROJECT SITUATION WITH THE *ICHAMATI* EMBANKMENT ALIGNMENT I (EXISTING ROAD)
OPTION 2B:	COMPARTMENTALIZATION PROJECT SITUATION WITH THE *ICHAMATI* EMBANKMENT ALIGNMENT II (ROAD ALONG RIVER BANK)

In OPTION 1, 2A and 2B a major breach in the BRE is not expected due to assumed proper sealing of the BRE. However, it should be noted that NO absolute guarantee can be given in spite of sealing or the timely construction of retired embankments.

The difference between OPTION 1 and OPTIONS 2A and 2B is that for OPTIONS an embankment along the *Ichamati* river/*khal* is foreseen. Flood protection measures are mainly taken in relation to the flooding from the *Ichamati* river/*khal*/branch.

Main features of the development options

FEATURES	OPTION		
	1	2A	2B
Flood protection from *Ichamati* back into CPP area	-	*	*
Embankment along existing roads	-	*	-
Embankment along river bank	-	-	*
Improved Drainage	*	*	*
Inlet structures at BRE	*	*	*
Structures at *Ichamati* branch and *khal*	*	*	*
Structures at Subcompartmental Boundaries	*	*	*
Structures at *Ichamati* East embankment	-	*	*
Water retention structures	*	*	*
Construction of structures which regulate inlet/outlet from subcompartment to subcompartment/*khal*.	*	*	*
Diversion of major quantities of drainage water which comes from north of the CPP-project area through the *Ichamati khal*/branch	*	*	*
BRE breach control works	*	*	*
Sirajganj town flushing inlets	*	*	*
Erosion protection works (related to structures)	*	*	*
Field Level Watermanagement	*	*	*

Implementation Costs

The cost estimates of the structural works of Options 1, 2A and 2B are summarized below:

Summary of construction cost of the three options, distributed over three years of implementation

ITEM	OPTION 1				OPTION 2A				OPTION 2B			
	Cost (Lakh)				Cost (Lakh)				Cost (Lakh)			
	94	95	96	Total	94	95	96	Total	94	95	96	Total
EMBANKMENT/ROADS	66		84	150	148	82	165	395	195	129	212	536
REGULATOR/BRIDGES	150	490	50	690	150	530	210	890	190	530	210	930
IMPROVING EXISTING	-	10	-	10	-	10	-	10	-	10	-	10
DRAINAGE CHANNELS	190	66	-	256	-	256	-	256	-	256	-	256
PROTECTION WORKS	-	58	57	115	-	58	57	115	-	58	57	115
EXTERNAL DEVELOPMENT	-	300	-	300	-	300	-	300	-	400	-	400
MITIGATION MEASURES	-	61	10	71	-	61	10	71	-	61	10	71
BRE REQUIREMENTS	13	13	14	40	13	13	14	40	13	13	14	40
SIRAJGANJ TOWN		93	93	186		93	93	186	-	93	93	186
Annual Cost	419	1191	308		311	1503	549		398	1550	596	
Total Cost				1918				2363				2504

Impact on Agriculture

CPP will facilitate agricultural production through improved water management at the field or chawk level. To a farmer, this means a safe crop environment, planned water utilization and a permanent opportunity to derive economic benefit from agriculture. This realisation among farmers will start a new batch of agricultural activities:

- a shift from single to double and from double to triple crop patterns.
- a shift from dominant variety Purbachi to BR14 and BR26 as HYVs of irrigated Boro.
- a shift from local to HYV Aman, specially BR22, BR23 and BR25.
- a gradual crop diversification in the dry season.

This means that the cropping intensity will gradually increase from 184% to 191% in Option 1, 205% in Option 2A and 200% in Option 2B.

There will be modest increase of Boro HYV area and sugarcane but a substantial increase in HYV T.Aman area. In the 'with project' situation, crop damage will be prevented. The area to other non-rice crops such as vegetable, mustard, potato and pulses will increase whereas the areas cropped with wheat and jute will decrease.

Impact on Fisheries

Under Option 1 the *beel* fish production increases from 12 t/year to 30 t/year if compared with the without case. This is mainly caused by an increased inundated area during the pre-monsoon as indicated by the hydrological model. This increase in inundated area does not occur within Option 2A and 2B. The calculated incremental production will be zero or slightly negative once this inundated area equals the inundated area under Options 2A and 2B. The floodplain production is probably somewhat under estimated due to the fact that the "fisheries" model does not take directly into account the "new situation" of hatchling migration through the constructed regulators. The direct effect is difficult to quantify as recruitment/yield figures are not yet known which limits at present the use of the hatchling migration data as obtained through the Special Fisheries Study. It is estimated that the incremental production could be in the order of 17 t/year.

Socio-economic Impact

The *farmers* will benefit, because of increased productivity of the land. This also applies to the small and marginal farmers and to the pure share-croppers. There will be an opportunity for additional full employment of 400-1300 person years.

The *landless* households inside the project will benefit much from the flood protection of their homesteads by a more secure BRE. They would also benefit from the reduced damage to infrastructure if the BRE does not breach. To the extent that they still own some agricultural land they would also benefit from the more secure crop environment provided by such an improved BRE. Landless might benefit indirectly through additional

employment in the agricultural sector, be it from a secure BRE or compartmentalization. In as much as agriculture is the "engine" of the rural economy, the landless may benefit from forward and backward linkages and a growing demand for localiy produced goods and services.

Many *fishermen* have changed in the past their profession or they migrated out of the area. This process is most likely to be continued. Further decline in fish production will put professional fishermen into an unattainable struggle for survival. Those who are engaged in subsistence fishing are getting approximately. 3.5 kg/person/year, which is almost half of the average per capita fish consumption in Bangladesh. This amount will be further decreased to approximately 3 kg/person/year with Option 2B..

CPP has paid specific attention to *women* allowing them to express their needs and their opinion. The possible impact on farmers affects also female family members and the possible impact on fishermen will affect their female family members:. The decrease in capture fish has a negative impact on diet and nutrition, since cash will be needed to buy fish. The decrease in income will affect the whole family and its well being. Increase in production of farmers will provide the family with more income. The expected increase in rice production will be positive for women processing rice and gaining employment. The female members of the farmers family will experience an increase in workload. The increased rice production will result in more straw, husk and bran for poultry and duck feeding. The employment opportunities that arise from construction and maintenance will be beneficial to women if and when the project achieves at least the quota of 50% women's participation in the contracts reserved for LCS.

The *urban population* in *Sirajganj* constitute about 45% of the population of the compartment, and this percentage is still rising and likely to continue to rise in the future. Although the town has been relatively well protected until now, the urban dwellers, and the industrial units and service sector, are likely to benefit from the psychological effect of a more secure BRE. The environmental condition in the town is likely to improve considerably by the proposed re-excavation of existing channels and building of flushing and drainage regulators. However, to substantially improve the environmental situation, the municipality will have to implement an integrated water supply, drainage, sewerage, solid waste disposal programme.

Environmental Impact

Environmental impact is evaluated in relative terms to compare the magnitude of negative or positive impacts among the options. The preferred Option 2A is preliminarily evaluated in qualitative terms for each important environmental element. Most important is the additional decrease in seasonal inundation and the consequent increase in terrestrial habitats to the potential benefit of intensified and more secured agricultural production. The accelerated shift to modern crop varieties, cropping systems and cultivation practices may result in increased biological imbalances and soil and water impairments, unless "best management practices" are widely used. Further potential negative impacts are associated with long term impacts on groundwater recharge and impairments of domestic water uses, further decline in capture fisheries and a long term extinction of permanent

aquatic habitats (*beels*) and wildlife species dependant on such habitats. Potential impacts on public health are probably balanced and there is potential for environmental management, such as flushing and water level or inundation manipulations to reduce water related diseases risks.

Mitigation and associated measures include: providing sufficient sluice gates with adequate design discharge to reestablish part of the *Jamuna* river flood and operational rules adjusted to a sound environmental management plan. Although the approach of the CPP permits considerable flexibility in impact reduction, there are several participatory and institutional preconditions which must be fulfilled that environmentally sound development can be achieved to the benefit of all affected people.

Institutionalization

The main objectives for CPP's institutionalization programme area:

- creating and testing mechanisms for the direct involvement and representation of the various interest groups concerned with water management in decisions and actions affecting their related interests;
- creating and testing mechanisms for direct and continuous exposure and support of the various government agencies concerned with effective use of land and water as well as local government structures and relevant NGOs;
- strengthening individual and collective interest and capabilities to deal with water management issues among selected governmental and non-governmental agencies at field, thana and district level;
- testing of institutional arrangements for integrated area-based water management at compartmental and sub-compartmental level and preparation of recommendations and guidelines regarding possible long-term institutional provisions in this regard;
- exploration of financial and practical aspects of water management at compartmental and sub compartmental level and preparation of recommendations regarding options for cost recovery and decentralization of Operation and Maintenance responsibilities.

During initial surveys conducted in *Sirajganj*, a high level of interest was found among governmental and non-governmental agencies. The need for coordination between and cooperation with different agencies is self-evident if the project's efforts are to result in a sustainable improvement of living conditions in the area. Still, present mechanisms for inter agency coordination and cooperation are very weak. Formal arrangements are required and will be established. The Institutionalization Programme will initiate activities to establish appropriate institutions at three levels; field, sub compartmental and compartmental level. This means the establishment of Water Users Groups, the Sub Compartmental Water Management Committee and the Compartmental Water Management Committee.

Environmental Appraisal for Option 2A of CPP Sirajganj

Environmental Elements	Extra CPP-Impact						Mitigation Cost	Type of Impact
	Beneficial			Adverse				
Regular Flooding of Croplands		x	o				High	IM
Cumulative Off-site Effects					x			LT
Flood free Land for Homesteads		o						IM
Loss of Land to River Erosion			o					
Containment of FAP Breach Floods		o off site			local	o		IM
River Flood Damage			o					IM
Drainage Network Conditions		o						IM
Groundwater Availability				x	o		Medium	LT
Surface Water Quality				x	o		Medium	LT
Groundwater Quality				x	o		Medium	LT
Soil Fertility Status				x		o	Medium	LT
Aquatic Habitat Status				x		o	High	IM
Terrestrial Habitat Status			o					IM
Wildlife				x		o	Medium	LT
Biological Imbalances				x		o	Medium	LT
Capture Fisheries				x	o		High	IM
Culture Fisheries			x	o			High	LT
Crop Production		o						LT
Homestead Plantation		x	o				Low	LT
Biomass Energy Production			x	o			Low	LT
Fodder Production		x	o				Low	LT
Communicable Diseases Water based Vector borne			x o	o			High	LT LT
Non communicable diseases Occupational Risks				x	o		Medium	IM
Water Pollution			x		o		High	LT
Excavation			x	o			High	IM
Construction Impacts					x		Medium	IM
	High	Medium	Minor	Minor	Medium	High		
	Beneficial			Adverse				

o Without Mitigating Measures

x With mitigation enhancement / associated measures

Type of Impact: LT, IM Long term or gradual versus immediate changes

Training

Training is an important component of the total efforts to establish a suitable institutional framework for water management under compartmentalization. The *Sirajganj* programme will wherever possible build on the experiences from Tangail. The training programme for CPP, including the choice of training methods, will have to pay explicit attention to this requirement for interactive and motivational training. The training needs assessment takes into account the innovative character of the project, as well as the fact that several techniques and approaches will be developed and tested by CPP itself which are not yet readily available elsewhere. Therefore CPP proposes for *Sirajganj* that the training programme include: participatory skill training, motivational value, on-the job and demonstration training, inter-agency participation, flexibility and replicability.

Training methods will be specific for each different course and even for separate course components. They will have to be negotiated in case a professional training institution is contracted. Formal training, study tours, workshops and seminars and the production and distribution of audio-visual aids are also proposed.

The cost estimate of the non-structural interventions has been calculated as:

	1993/94	1994/95	Total Lakh Tk
1 Consultation process	3	2	5
2 Establishing CPP/SC and SCWMC	2	1	3
3 Establishing WUGs	15	8	23
4 Establishing SCWMCs	1	3	4
5 Facilitating UCSs and EMGs	2	2	4
6 Publicity and information	2	1	3
7 Seminars, courses, workshops	3	4	7
8 Training in Bangladesh	4	5	9
9 Training outside Bangladesh (Except Netherlands)	15	16	31
10 Training in The Netherlands	6		6
Total	53	42	95

Implementation Schedule

The work planning of structural and non-structural interventions have been merged in such a way that a fine tuned match is found between these components.

The main points from the proposed implementation schedule are:

The consultation process in all its phases preceeds any structural intervention.

The priority is given to consultation and a direct follow up by implementation of structural elements in the SC 1, 2 and 3 for the first year. This allows sufficient time for the consulation proces to be performed in all the other SC's in the second (1994/1995) year.

The priority is based on the assumption that although the BRE is sealed, there is still a chance that a breach may occur under exceptional circumstances. Therefore, the protection of the compartment should receive first priority in case a breach occurs.

Operation and Maintenance

The complexity of the *operations* for the structures and the scope of their impact will determine which institutional arrangements for its operation are desirable. The actual competence of a particular institution will determine whether responsibilities for operation will indeed be delegated to that institution, possibly after training and with provisions for technical advice.

Summarizing the operating rule will be that the responsibility for operation of structures will be put at the lowest possible level (which will normally be the level which is exclusively affected by the structure) with consultation towards the next lower level and supervision by the next higher level. In the following diagram these various aspects are displayed.

STRUCTURE TYPE	deciding agency	consultation	operat criteria	executing agency	controling
Peripheral control structure	BWDB	MIWDFC	regional WL	BWDB operator	MIWDFC
BRE inlet structure	BWDB	SCWMC	US/DS WL	CWMC operator	BWDB
compartmental outlet structure	CWMC	SCWMC	US/DS WL	CWMC operator	BWDB
sub-compartmental regulator	SCWMC	WUG	US/DS WL	SCWMC operator	CWMC
waterretention structure	SCWMC	BWDB	US/DS WL	SCWMC operator	CWMC
Sirajganj town flushing sluice	CWMC	DPHE Municipality	US/DS WL	CWMC operator	CWMC
minor drainage outlet	SCWMC	WUG	US/DS WL	SCWMC operator	CWMC
irrigation inlet	SCWMC	WUG	rain/ flood	SCWMC operator	CWMB
irrigation pass	WUG	farmers	rain/ flood	WUG operator	SCWMC

Following abreviations have been used:

MIWDFC Ministry of Irrigation Water Development and Flood Control
BWDB Bangladesh Water Development Board
CWMC Compartmental Water Development Committee
SCWMC Sub-Compartmental Water Management Committee
WUG Water User's Group
US/DS WL Upstream and Downstream water Level
DPHE Department of Public Health Engineering

For the various *maintenance* activities, preventive, periodic and emergency maintenance and rehabilitation, responsibilities will be laid in the hands of WUG, SCWMC or CWMC, depending on the level required. The actual realizaiton will be done by three types of maintenance groups:

- SMG : Structures Maintenance Group
- EMG : Embankment Maintenance Group
- CMG : Channel Maintenance Group

Monitoring and Evaluation

As a Pilot Project it is important that a number of important aspects are monitored and evaluated, from Planning and Design to Impact Assessment. The Monitoring and Evaluation (M&E) programme for *Sirajganj* similar to that of *Tangail*. It is not intended to establish a separate M&E unit. Instead CPP staff will carry out most of the work. To make this practical, four basic principles have therefore been adopted:

a) that all significant aspects are monitored effectively;
b) that the simplest possible approach is taken;
c) that priority be given to early-warning indicators, those that will quickly show up where action to solve problems is needed;
d) that all aspects will be monitored on simple standard formats which will be as easy as possible both to prepare and, for the users, to read and interpret.

The monitoring and evaluation programme will be carried out under three headings: Project Implementation, System Establishment and Operation and Impact Assessment. The monitoring programme encompasses hydrology, environment, socio-economic, institutional and training aspects. The impact and evaluation will be in three parts: economic, environmental and institutional.

Special Studies

Studies are planned in the field of agriculture and fisheries, socio-economic development and transport and marketing. Special emphasis will be on a number of water-related environmental surveys, studies and initiatives. The output will constitute a substantial part of the monitoring and evaluation programme.

Multi-Criteria Analysis

Although the core of the analysis consists of an economic evaluation of mainly the expected impact on agriculture and the assessment of damage prevented in the future, all other aspects with bearing on the project have been included as well. They have been analyzed as thoroughly as those mentioned above. As this task included all fields of expertise involved the analysis truly reflects a multidisciplinary approach.

The economic criteria used are summarized as follows:

Criteria	Unit	Options					
		Option 1		Option 2A		Option 2B	
		Econ	Fin	Econ	Fin	Eco	Fin
Investment cost	Tk mln	157	200	190	244	199	259
Foreign Exchange	%	39	39	38	38	36	36
Engineering cost	Tk mln	24	30	28	37	30	39
Total Investment	Tk mln	181	230	218	281	229	298
Recurrent cost	Tk mln	8	10	13	16	14	17
Total benefits	Tk mln	26	30	60	70	62	73
IRR	%	5.9	4.3	15.7	13.2	15.2	12.0
NPV	Tk mln	-73	-115	57	25	52	0
B/C Ratio		.69	.62	1.18	1.05	1.10	1.00

The total benefits are mainly derived from an increase in agricultural production and from the prevention of damages, as shown below:

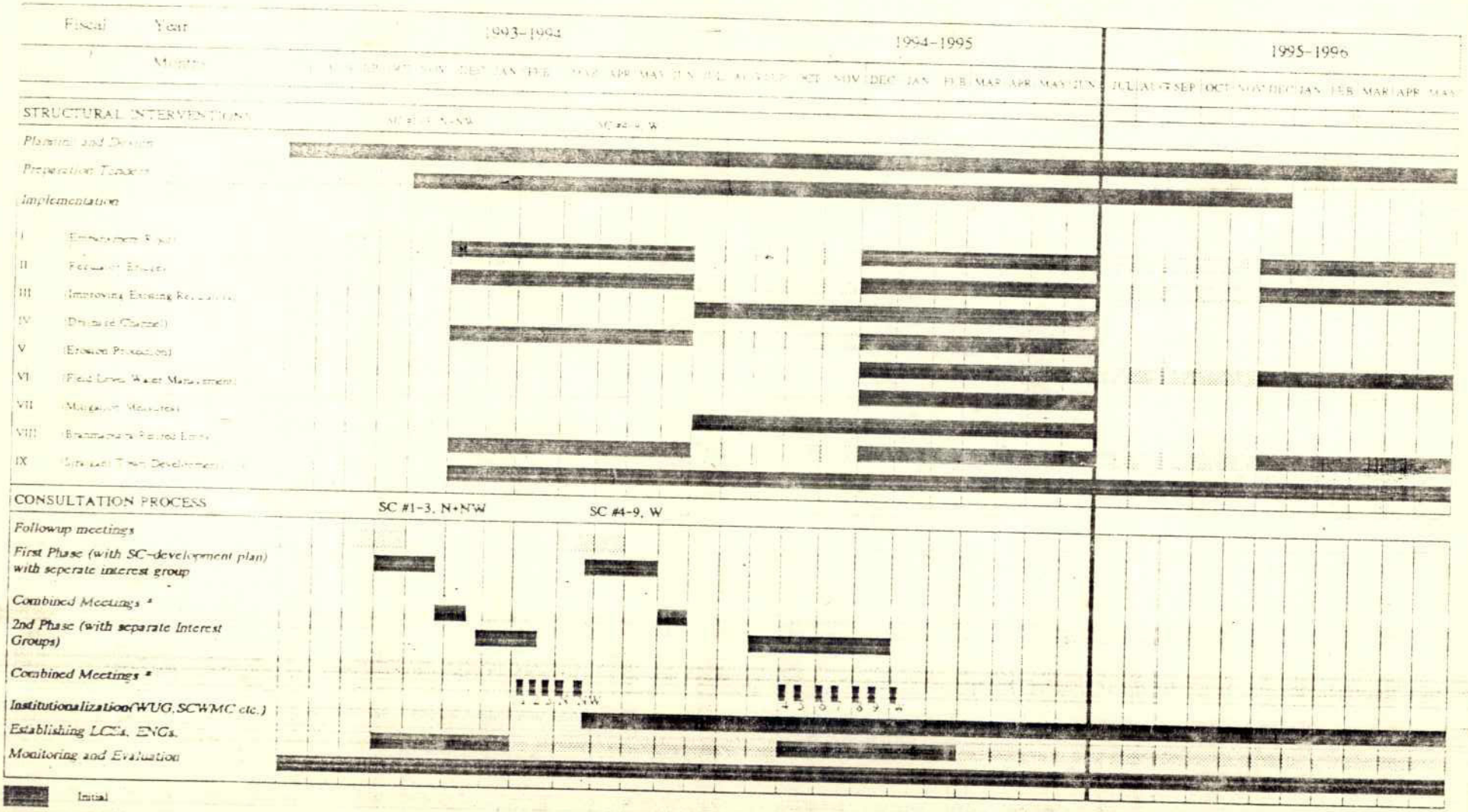
Criteria	Unit	Options					
		Option 1		Option 2A		Option 2B	
		Econ	Fin	Econ	Fin	Econ	Fin
Agriculture	Tk mln	17	20	50	59	53	62
Damage prevented	Tk mln	7	7	7	7	7	7
Others	Tk mln	2	3	3	4	2	4
Total	Tk mln	26	30	60	70	62	73

A further qualitative assessment of several aspects concerning natural resources, environment, agriculture, fisheries, women, communication, health, social issues and others has been made also.

Concluding Remark

Considering the outcome of the multi-criteria analysis at this stage, no definite recommendation can be made as to the final selection of one particular development option. It is clear, however, that Options 2A and 2B are preferable to Option 1. It is therefore proposed to carry out additional consultations and analyses to determine the comparative advantages of Options 2A and 2B. The result might very well be, that the optimum solution will turn out to be a combination of both options. The outcome, however, does not interfere with the proposed implementation schedule.

GENERAL IMPLEMENTATION SCHEDULE OF CPP SIRAJGANJ : 1993–1995 (1996)



* Including contact persons, elected representatives, local elites, village matabbars etc.

ii ACKNOWLEDGEMENTS

Without the contributions from a number of other FAP projects this report could not have been completed in time. We are especially grateful to FAP 1 (info BRE); FAP 2 (North-West Regional Study); FAP 12 (Agricultural Review); FAP 13 (O &M Study); FAP 16 (Environmental Study); FAP 17 (Fisheries Study); FAP 19 (GIS); FAP 21/22 (Bank Protection and River Training) and FAP 25 (Flood Modelling/Management).

In Sirajganj, District-and Thana Officers of various Departments have been very cooperative. Especially the Deputy Commissioner (DC); The Thana Nirbahi Officer (TNO); Department of Agricultural Extension (DAE); Bangladesh Rural Development Board (BRDB); Bangladesh Agricultural Development Corporation (BADC), (Department of Fisheries(DOF); DOL (Department of Livestock); LGED (Local Government Engineering Department), Department of Cooperatives, Department of Social Service (DSS); Bangladesh Water Development Board - Operation & Maintenance (BWDB - O&M); Department of Health; Union Parishads (UPs) and Pourashava should be mentioned. Marketing Department and Department of Relief and Rehabilitation provided many data.

Other agencies consulted include:

Survey of Bangladesh, Directorate of Fisheries, Ministry of Fisheries & Livestock, Surface Water Modelling Centre (SWMC), Water Resources Planning Organization (WARPO), Proshika, Mymensingh Extension & Aquaculture Project, Noakhali Rural Development Project, International Centre for Living Aquatic Research and Management, Dhaka, Fisheries Research Institute Mymensingh.

Furthermore, a number of NGO's and other institutions have actively assisted in the preparation and organization of consultation meetings in the field and also provided data for the institutional survey.

The assistance and guidance from FPCO/POE has been very stimulating indeed. We are grateful also to different offices of BWDB, executing agency of this project such as Design Office, O&M Division and Hydrology.

The technical support from the DDC for the preparation of figures, maps and drawings, in cooperation with FAP 19, has been highly appreciated.

The CPP staff involved in this planning report (both Project and Consultant Team) were only able to work efficiently with the continuous support of the office and support staff.

Lastly, we want to express our gratitude to the people of Sirajganj for their patience, hearing and valuable suggestions during many meetings and interviews in different stages of the project.

iii ABBREVIATIONS

AEZ	- Agro-Ecological Zone
ASSP	- Agricultural Support Services Project
BADC	- Bangladesh Agricultural Development Corporation
BBS	- Bangladesh Bureau of Statistic
B/C ratio	- Benefit/Cost ratio
BFRSS	- Bangladesh Fisheries Resources Survey System
BLE	- *Brahmaputra* Left Embankment
BMDC	- Bangladesh Management Development Centre
BRAC	- Bangladesh Rural Advancement Committee
BRDB	- Bangladesh Rural Development Board
BRE	- *Brahmaputra* Right Embankment
BURO	- Bangladesh Unemployment Rehabilitation Organization
BWDB	- Bangladesh Water Development Board
CARE	- Co-operative for American Relief Everywhere
CFD	- Controlled Flooding & Drainage
CMG	- Channel Maintenance Group
CPP	- Compartmentalization Pilot Project
CPPSC	- Compartmentalization Pilot Project Steering Committee
CWMC	- Compartmental Water Management Committee
DAE	- Department of Agricultural Extension
DC	- Deputy Commissioner
DHI	- Danish Hydraulic Institute
DOF	- Department of Fisheries
DPHE	- Department of Public Health Engineering
DS(WL)	- Downstream Water Level
DTC	- District Technical Committee (Agriculture)
DTW	- Deep Tube Well
EIA	- Environment Impact Assessment
EIIR	- Economic Internal Rate of Return
EMG	- Embankment Maintenance Group
FAP	- Flood Action Plan
FCD	- Flood Control and Drainage
FCD/I	- Flood Control, Drainage and Irrigation
FPCO	- Flood Plan Co-ordination Organization
GIS	- Geographical Information System (FAP-19)
GOB	- Government of Bangladesh
GPS	- Global Positioning System
GPV	- Gross Product Value
GPA	- Guideline for Project Assessment (FPCO 1992)
ha	- Hectares
HYV	- High Yielding Variety
ICDDR,B	- International Centre for Diarrhoeal Disease Research, Bangladesh
ISPAN	- Irrigation Support Project for Asia and the Near East
LCS	- Landless Contracting Society
LGED	- Local Government Engineering Department
LLP	- Low Lift Pump

MARC	-	Multi-Action Research Centre
MIWDFC	-	Ministry of Irrigation, Water Development and Flood Control
MOT	-	Manually Operated Tubewells
M&E	-	Monitoring and Evaluation
MDF	-	Management Development Foundation, Netherlands
MP	-	Muriate of Potash
MPO	-	Master Plan Organization (now WARPO)
NAM	-	Rainfall-runoff module of MIKE 11
NAS	-	Needs Assessment Survey
NCA	-	Net Cultivable Area
NCRS	-	North Central Regional Study (FAP 3)
NGO	-	Non-Government Organization
NWRS	-	North West Regional Study (FAP 2)
NPV	-	Net Present Value
O&M	-	Operation and Maintenance
PSA	-	Production System Analysis
PWD	-	Public Works Department
R&H	-	Roads and Highways
SC	-	Sub-Compartment
SCWMC	-	Sub-Compartment Water Management Committee
SCF	-	Standard Conversion Factor
SMG	-	Structure Maintenance Group
SRP	-	Systems Rehabilitation Project
SWMC	-	Surface Water Modelling Centre
SIRDP	-	Sirajganj Integrated Rural Development Project
STW	-	Shallow Tube Well
SMG	-	Structure Maintenance Group
TNO	-	Thana Nirbahi Officer
TSP	-	Triple Super Phosplate
ToR	-	Terms of Reference
UNDP	-	United Nations Development Programme
UP	-	Union Parishad
US(WL)	-	Upstream Water Level
WARPO	-	Water Resources Planning Organization
WUG	-	Water User Group

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iv GLOSSARY

Aquaculture	-	The cultivation of aquatic products
Aman	-	A group of photoperiod-sensitive rice planted in July-August and harvested in November-December.
Aus	-	A group of photoperiod-insensitive rice varieties sown during March-April and harvested during June-August.
Beel	-	Small lake, low-lying depression, a permanent body of water in a floodplain or a body of water created by rains or floods.
Boro	-	A group of photoperiod-insensitive but fairly cold tolerant rice varieties transplanted in December-February and harvested in April-May.
Borrowpit	-	Excavated small and seasonal waterbodies present mainly along the public roads.
Chawk	-	A chawk is readily recognigeable manageable field unit bounded by village road and settlement areas. These are physical entities and are easily recognised by village people. Each chawk has water inlet or outlet through bridges, culverts, road breaches etc.
Compartment	-	A (semi) protected area or part thereof in which effective water management particularly through controlled flooding and controlled drainage, is made possible through structural and institutional arrangements. A compartment will be sub-divided into Sub-Compartments and operational Water Management Unit.
Compartmentalization	-	The spreading of the flood water over the flood plains by establishing interlinked compartments, with the objective to provide a more secure environment for agriculture, fisheries and integrated rural and urban development through water management (controlled flooding and drainage).
Controlled drainage	-	The control of the water flow out of a (sub)compartment according to the local or regional requirements.
Controlled flooding	-	The spreading of the flood over the land in a (semi)controlled way with the help of provisions incorporated in compartments, embankments, roads etc.

Embankment breaching - A breach is an occurrence in the embankment in which physical damage, directly or indirectly by the external river water has caused an opening such that river water freely flows into the compartment in an uncontrolled way.

Embankment failure by Erosion - If the embankment is eroded due to the bank erosion of the main river, it is termed as embankment failure by erosion.

Embankment Sealing - An embankment is assumed to be sealed if the quality and locality of the embankment is such that embankment breaching - eroding may occur once in a 5-year period.

Fully-controlled structure - A structure through which the water flow can be fully regulated.

Jalmahal - A leased waterbody or river stretch.

Khal - A natural channel.

Mike11 - A commercially available software package which contains a number of process module developed by the Danish Hydraulic Institute (DHI) and is taken for unsteady flow simulation in Bangladesh.

Multi-criteria analysis - An analysis and display of the impacts of proposed structural and non-structural works in which a wide range of criteria are used, such as social, environmental and economic. Impacts can be quantified in financial terms or may be evaluated using a scale from -5 to +5. Those items that cannot even be rated on such a scale are dealt with in a descriptive way.

Pagard - A small waterbody, generally excavated near a homestead, which is used for fish stocking as well as for household activities.

PA-Matrix - A relational matrix, depicting links between participants and activities in a certain process.

Rapid Rural Appraisal - A systematic, but semi-structured activity carried out in the field by a multi-disciplinary team and designed to quickly acquire information.

Salish - Traditional informal village court which mitigate the disputes of the villagers. The traditional village Matabbars (Chieftains) are the judges.

Sub-Compartment	-	A sub-unit of a compartment, in which to a certain extent the water management can be controlled by the people living in the area represented in a Water Committee. The sub-compartment is mostly separated from the adjoining ones by embankments or roads provided with (semi)controlled structures.
Thana (previously Upazila)	-	Local administrative unit. Each Thana is composed of 10-15 Unions.
Union	-	Smallest electoral unit of areas outside municipalities comprising several mouzas (or villages), and generally divided into three wards. It has an Union Parishad (Council).
Water Management	-	It is the controlled quantitative and qualitative usage of water, including early late and deep flooding, rainfall and groundwater for agriculture, fisheries, transport, sanitation, domestic and industrial purposes.

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TANGAIL INTERIM REPORT, ANNEXES 1-7, CPP, September 1992

vi STUDY TEAM

The *Sirajganj* CPP Interim Report has been prepared by an integrated CPP-team consisting of members of the Project Team and the Consultants Team.

Project Team

Md Obaidur Rahman, Project Director and Superintending Engineer CPP
G.M. Shamsur Rahman, XEN Sirajganj
A.Q. Ziauddin, Agronomist (until April)
Ahmed Ali, Agronomist
Ghulam Kibria, Sociologist
Nowshad Ali, SDE-I
Abuzar Hossain, SDE-II

Consultants Team

J.B. (Hans) Visser, Team Leader
Golam Kibria, Mathematical Modeller
Dirk Frans, Sociologist
Dr. Armand Evers, Drainage Engineer
Dr. Rafiqul Islam, Agronomist
Dibakar Dhar, Civil Engineer
Mujibur Rahman, Drainage Engineer
Hasnahena Akter, Sociologist-cum WID Specialist
Els Kocken, Women in Development Specialist
Md Tofazzal Hossain Bhuiya, Monitoring and Evaluation Expert
James Morton, Monitoring and Evaluation Expert
Gert-Jan de Graaf, Fisheries Specialist
Gazi Nurul Alam, Fisheries Specialist
Abu Mostafa Kamal Uddin, Junior Biologist
Md Mohsin, Institutional Specialist
Martin de Graaf, Institutional Specialist
Rens Verstappen, Training Specialist
Dr. A.K.M.H. Talukdar, Environmentalist
Dr. Thomas Petermann, Environmentalist
Md Tauhidun Nabi, Sociologist
Richard Wiens, Agro-Economist
Abdul Latif, Economist

Multi-Disciplinary Action Research Centre (MARC) (Household Survey)

1 INTRODUCTION

1.1 The Flood Action Plan

Following the disastrous floods of 1987 and 1988 several studies were undertaken to investigate how to protect the country better against the devastating effects of the floods. The results of these studies showed a set of alternatives, with on the one side 'full protection' and on the other side 'living with the floods'.

Bangladesh adopted the outlines of an Action Plan for Flood Control and Drainage in June 1989 and the Government of Bangladesh requested the World Bank to assist in preparing a Flood Action Plan (FAP). This request was endorsed at the G-7 meeting of industrialized countries in July 1989, which called for the international community to help find solutions to the flood problem in Bangladesh which are 'technically, socially, financially, economically and environmentally sound.' The FAP was in turn endorsed at a special conference of the Government of Bangladesh and donor organizations in London in November 1989, and is presently being implemented.

The FAP comprises a number of studies and pilot projects which are expected to lead to water resource management and related projects, with an emphasis on flood control and drainage. In the first two years of the Plan, 1990-92, Regional Water Resource Development Planning Studies are being undertaken to identify alternative water resource management strategies for different regions of the country. These will be followed by feasibility studies for priority investment projects. A number of complementary socio-economic and environmental studies are being carried out in order to improve understanding of the impact of flooding and of Flood Control, Drainage and Irrigation (FDC/I) projects, and to recommend economic, social and environmental guidelines and criteria appropriate for use in planning and implementing such projects. While the emphasis of the Regional Studies is on flood control and drainage, other problems such as saline intrusion will also be addressed.

The main focus of the Flood Action Plan is defined by the Government of Bangladesh in the well-known Eleven Guiding Principles. Emphasis is given on 'controlled flooding' and 'controlled drainage' where possible in combination with flood protection. Floods would be controlled in such a way that maximum profit can be achieved from the beneficial effects of river water flooding, while minimizing the disadvantages. The Action Plan comprises twenty-six components and supporting activities. The Compartmentalization Pilot Project (CPP) - FAP 2 - is one of them.

1.2 Controlled flooding and drainage

Many classify all flooding as undesirable and flood relief often gets political support and foreign assistance. Yet, the rural population perceive normal flooding as a very positive factor in the seasonal cycle. The mechanisms behind the positive influence of the normal flooding, in combination with rainfall, on agriculture (silt deposit and/or nitrogen fixation through blue-green algae growth) and on fisheries, is the subject for many academic

discussions and much research. Lately, there is a growing awareness among scientists that the floodplain population may well have a more comprehensive view of flooding than most outsiders. Therefore a cornerstone of the approach is to involve the intended beneficiaries, and those likely to be adversely affected by works of FAP projects including the Compartmentalization Pilot Project. This involvement applies to all stages of project planning, design, construction, operation and maintenance and monitoring and evaluation.

It will be necessary to make a distinction between flooding which originates from rivers and flooding from local rainfall. Control of flooding from rivers can be achieved through the construction or rehabilitation of river embankments with control structures. One of the main issues here is to consider the effect of flood control on the neighbouring areas. Control of flooding inside the embankment (compartment) from local rainfall is basically a matter of (temporarily) flood retention within the operational units to avoid that flood water will accumulate in the low lying areas. The realization of this objective is more a matter of improving the internal drainage system, but is bound by downstream water level conditions.

1.3 The concept of compartmentalization

The concept of compartmentalization is introduced in the GOB/UNDP study "Bangladesh Flood Policy Study" (May 1989). According to the Flood Action Plan, which resulted from this study, the areas at the right and left bank of the *Brahmaputra* would be subdivided into compartments.

The flood water will flow into the compartment and spread over the area in a (semi)-controlled way by means of regulating structures in the primary embankments along this river and the gated or ungated openings in the secondary embankments between the compartments. The structural and non-structural measures to achieve this can be called the macro (main) system.

The way the flood, as well as the drainage of excess rainfall, has to be controlled will be determined by the demands from inside the compartment. The required structural and non-structural measures for water management within the compartments can be called the micro (minor) system.

The concept of compartmentalization is instrumental for the implementation of water management interventions.

The following definition will be used:

> *A compartment is a (semi-)protected area or part thereof in which effective water management, particularly through (semi-)controlled flooding and controlled drainage, is made possible through structural and institutional arrangements. Compartmentalization is linked to area development with sound water management as the main agent. A compartment will be sub-divided into sub-compartments and operational water management units.*

It is obvious that a compartment can be a large area and that hydrology, topography, existing infrastructure, landuse and administrative boundaries are important factors to consider. In analogy with an irrigation system, it is possible to make a distinction between the macro (main) system and the micro (minor) system. Clearly, to make the participation of the beneficiaries in project planning, design, construction, operation, maintenance, monitoring and evaluation successful, it will be necessary to subdivide the compartment into rather small units.

The criteria to design a compartment and its subdivision into operational units or (a combination of) sub-compartments are subject of the CPP study. Units are designed in such manner that they are homogeneous in many ways, as well as manageable as a distinct unit. The following factors have been considered for the *Sirajganj* Pilot Project:

- **Physical parameters**; the topography and hydrology of the area will have a significant effect on the size of the units; an operational unit should preferably have its own facilities for controlled flooding and drainage; assuming that it will be convenient from a management point of view that each unit is identified with a specific preferable water level and an associated management mode within the unit.

- **Landuse patterns**; different landuse patterns require different water management modes; in order to simplify the management of the units; predominant landuse should be the aim in selecting water management units.

In the future also other factors may have to be taken into account:

- **Administrative boundaries**; in the design and management of irrigation systems, it can often not be prevented that administrative boundaries and the boundaries of the water management (tertiary) unit do not coincide. This complicates the functioning of the Water User Groups. A compartment is not the same as an irrigation system but, certainly, there are some lessons to be learned from experience with the management of irrigation systems in the design of water management systems for compartments.

- **Social homogeneity**; operational units should also, from a social point of view be as homogeneous as possible. Using landuse as a criterium for the design of the operational unit may in itself result in some homogeneity of the group within the unit. By aiming at rather small units, social homogeneity will also be enhanced.

- **Manageability**; O&M of the smaller operational units should as far as possible be the responsibility of the beneficiaries themselves (Water User Groups). In the design of irrigation systems, it is generally accepted that service units should not be much larger than 50 hectares, or not more than 30 to 40 farmers should have land in these units.

Moreover, sub-compartments may be sub-divided for economic or operational reasons at a later stage. Finally, operational linkages should be established between sub-compartments.

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Moreover, sub-compartments may be sub-divided for economic or operational reasons at a later stage. Finally, operational linkages should be established between sub-compartments.

1.4 Application of the concept: CPP-FAP 20

1.4.1 The objective

The overall objective of FAP 20 is:

> *"....to establish appropriate watermanagement systems for the development of protected areas so that criteria and principles for design, implementation and operation can be made available for the Action Plan."* [ToR, page 4].

Specifically this will entail the

> *"...testing of the compartmentalization concept in the field under real operating conditions, addressing all relevant socio-economic, institutional and environmental issues and trying out water control works and water management systems."* [ToR, page 4].

FAP 20 has to produce not only the structural works and an institutional set-up for the compartments *Tangail* and *Sirajganj*, but also criteria, guidelines, manuals and a training and demonstration programme for the establishment of other compartments.

1.4.2 Water management

Water management projects must not only take the needs of agriculture into account, but also:

- the needs of the non-crop sectors such as fisheries and livestock, as well as transport and industry (rural as well as urban);
- the need to manage conflicting interests, such as between low- and high- land farmers, between farmers and fishermen and between those inside and outside the boundaries of the project; and
- the need for widespread popular support through people's participation, so as to facilitate input into design, planning, operation and maintenance of structures, including embankments.

Water shortages should be minimized by water supply, and excess of water should be minimized by improved flood control and drainage.

In FAP 20 water management is therefore defined as follows:

> *Water management is the controlled quantitative and qualitative usage of water, including early, late and deep flooding, rainfall and ground water for agriculture, fisheries, transport, sanitation and domestic and industrial purposes.*

Water management ideally is a continuous process in which the people concerned participate in a decisive way. It starts with the identification of the existing water related problems and possibilities, followed by planning, design, construction, operation and maintenance, but also monitoring and evaluation of the results. Water management includes reconciling competing interests and it should lead to sustainable development.

It is, therefore, necessary to institutionalize the people's participation in water management. Of course, this will not be easy. However, farmers do cooperate **informally** for irrigation, ploughing etc and in the *Salish* to reconcile disputes.

This water-management-related institutionalization will have to be initiated at the local level, but will ultimately have to extend all the way up to the national (and even the international) level. It will also have to include legislation, including the formulation of by-laws, defining rules and regulations about the privilages and duties of the people and institutions concerned. Here again, it is necessary that these institutions are sustainable, and accepted as legitimate by the people.

1.4.3 People's participation

The FAP 20 ToR puts much emphasis on people's participation and its institutionalization;

> *"The compartment is basically a management unit in which the involvement of beneficiaries is considered essential for its success."* [ToR, p. 3]
>
> *"The non-structural output which constitute the basic objectives of the Pilot Project will cover the following:*
>
> .....
>
> *2. Social Aspects*
> *Policies and Guidelines of involving the scheme beneficiaries and disadvantaged groups in the planning and implementation of physical works and their management*
>
> ...
>
> *4. Institutional Arrangements*
> *Policies and Guidelines for strengthening existing institutions and/or establishing new ones for the management of compartments or sub-compartmental development with the emphasis on local government and beneficiary participation* .... [ToR page 6, 7)

The need for this emphasis on the non-structural aspects of compartmentalization has strongly been indicated by evaluations of existing FCD/I projects (see particularly FAP 12/13). These have highlighted that success and sustainability requires people's participation in all phases of such projects and close collaboration between and within the various government organizations. This was reconfirmed during the Third FAP conference (May, 1993).

FAP 20 has therefore designed a comprehensive programme to involve all concerned in the process of designing, operating and testing compartmentalization. As mentioned in the

Inception Report (April 1992) people's participation can be anything between genuine grassroots development and the "selling" of a programme (designed by others) to the people concerned. FAP 20 proposed follows neither of these extreme approaches. Within the limits set by the specific objectives of FAP 20 ("testing the compartmentalization concept in the field under real operating conditions"), a "bottom-up" approach is attempted.

1.4.4 The Sirajganj CPP

Whereas the Tangail Compartment was chosen because of the existing horseshoe embankment (pending possible future construction of the BLE), the *Sirajganj* compartment was selected because of direct protection by a main embankment, the existing BRE.

The BRE protected the area quite satisfactorily for about 20 years but not any more since 1984. Farmers lost their confidence in flood protection due to frequent breaches and many had to return to pre-BRE agricultural practices. In addition to the demand for reliable flood protection people expressed demand for controlled flooding. Drainage congestion is a second constraint for agricultural development.

In October/November 1991 a reconnaissance survey of the *Sirajganj* CPP area was conducted. The outcome of this survey was a renewed stress on the importance of a secure BRE for the area. The survey resulted in a note to FPCO (January 1992) suggesting that the area might not be the most suitable for testing the compartmentalization concept.

Since 1984, the area has suffered regular BRE breaches, and the present socio-economic and agricultural situation is more like that of a partly unprotected area. However, the *Sirajganj* area was chosen to represent the areas that have had protection from the river *Jamuna* for a considerable time.

The breaching of the BRE raises two problems for testing the compartmentalization concept in this area. Firstly, if the BRE is strengthened and compartmentalization implemented simultaneously, then it will be very difficult to separate the impact of either at the end of the project cycle (5 years). Secondly, people's participation might result in focussing the project on the BRE instead of on compartmentalization.

FPCO/POE recognized the problems mentioned, but advised (minutes of meeting held on 20-1-92 at FPCO) that *Sirajganj* was still the best of the available options.

A secure main embankment can be seen as one of the pre-conditions for a successful operation in the CPP. However, the strengthening and maintenance of the main embankment is beyond the task of FAP 20. FAP 1 has to produce a plan to increase the security of the BRE. The BWDB is responsible for the maintenance and for a timely retirement of the embankment, if needed. In the ToR it is assumed that measures will be taken to eliminate the hazard of flood damage resulting from breaching of embankments.

1.5 Objectives of the report

As per ToR and inception report, the objective of this *Sirajganj* CPP interim report is to outline the progress and planning of the various required project outputs. The report includes the cost and benefit estimates of structural and non-structural activities and a multi-criteria analysis. The report also includes the planning for the forthcoming design and construction.

The report should contribute to a balanced approach as to the further planning, design and implementation of both the structural and non-structural components for developing the water management systems of the *Sirajganj* CPP. It goes without saying that the real outputs will be only known after testing the results of the various interventions.

If so required, the planning and programme for the remaining project period will be amended, adjusted or postponed depending on the outcome of the appraisal in September 1993.

1.6 Organization of the report and its annexes

The **Main report** is organized in such a way that a logical sequence of past, present and future project activities has been described. All on-going and planned interventions are based on the results, interpretation and analysis of the various surveys carried out as described in Chapter 2. In Chapter 3 the targets for structural and non-structural elements are outlined.

The core of this report is Chapter 4, in which the planning and design of the various project activities have been discussed and further studies have been proposed. The time frame in which the outputs should be realized and the related cost estimates are presented in Chapter 5.

An assessment of the impacts of the proposed measures are elaborated in Chapter 6. In Chapter 7 technical and institutional aspects of operation and maintenance have been discussed. Finally, a multi-criteria analysis, including an analysis of the direct and indirect costs and benefits and of other qualitative impacts has been described in Chapter 8.

The **Annexes**, including their Appendices, contain all supporting data, detailed sectoral analysis, engineering design assumptions and criteria and of course proposals for institutionalization of all measures. Cross-references are given where relevant. However, each Annex is formulated is such a way that it can be read independently from the others. In doing so some duplication could not be avoided. The voluminous Appendices to the Annexes 1 and 8, Needs Assessment Survey and Household Survey will be made available on request only.

2 PRESENT SITUATION

2.1 Sirajganj CPP area

2.1.1 Regional context

The *Sirajganj* CPP area is part of the *Karatoya-Bangali* floodplain (agro-ecological zone 4), and overland drainage is parallel or away from the BRE. A relatively large part of the land is high and sandy (particularly close to previous breaches), with in general a smooth relief. The area to the north has drainage towards CPP while the area to the south faces backwater flooding via the *Hurasagar* and *Karatoya* rivers (Figure 2.1).

FAP 2, the North-West Regional Study (1992) stated the following about the plans for the BRE:

> *"Sealing of the BRE is therefore the priority measure for the region. This is the responsibility of the FAP 1 project (.....)". 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. In addition, consideration has been given to producing 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".*

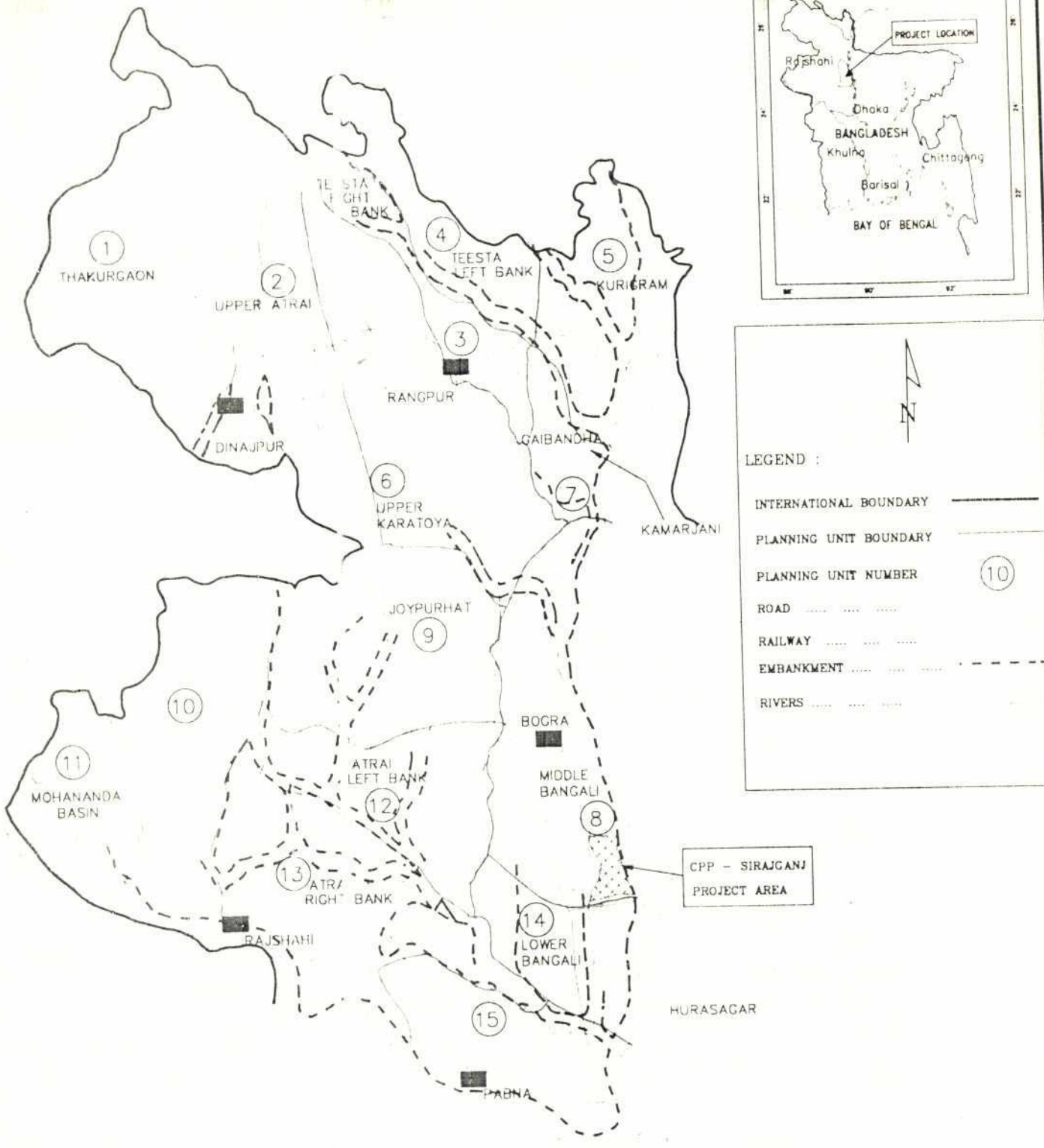
2.1.2 Location

The compartment is bordered in the east by the *Brahmaputra* Right Embankment (BRE) between *Sirajganj* town and *Banglabazar* of *Kazipur* Thana and in the west by the *Ichamati* river between *Bhadraghat* and *Brahmagacha*. In the south, the border follows new *Bogra* road from *Bhadraghat* to crossing of *Soyadhan Khara* road going still southward and along *Qaumi* Jute Mill road to the BRE. In the north, the boundary follows *Ichamati branch* up to *Bagbati Ghat* and then along the *Ichamati khal* crossing at *Chilgacha* bridge and then the paved road to *Ratankandi* and *Banglabazar* at the BRE (See separate map in back of the report).

The compartment belongs mainly of *Sirajganj Sadar* (95%). Other Thanas involved are *Kazipur* (2%), *Raiganj* (2%) and *Kamarkhand* (1%). The total area of the CPP, *Sirajganj* compartment is 12,057 ha. The number of villages in the CPP area is 125.

2.1.3 A Short History of Sirajganj

During the *Mughal* period, portions of *Sirajganj* was included in the Zamindaries of *Barabazu* and *Kagmari*. *Rajab Ali Chowdhury* was Zamindar of *Barabazu* sometime before the permanent settlement. His descendant, *Seraj Ali Chowdhury*, gave his name to the area.



MINISTRY OF IRRIGATION, WATER DEVELOPMENT AND FLOOD CONTROL
BANGLADESH WATER DEVELOPMENT BOARD
FLOOD PLAN COORDINATION ORGANISATION

COMPARTMENTALIZATION PILOT PROJECT SIRAJGANJ (FAP 20)

CPP–SIRAJGANJ WITHIN NWRS PLANNING UNITS

Consultant: Euroconsult, Lahmeyer Int.,Beta Ltd.,HCL

Figure No. 2.1

C
FAP20
P

At the time of permanent settlement in 1828, *Sirajganj*, as a Thana, was part of *Mymensingh* district. The river *Jamuna* was fixed as the eastern boundary of *Pabna* in 1848 and owing to a change in its course, *Sirajganj*, upgraded as sub-division, was transferred from *Mymensingh* to *Pabna* in 1855.

In historical reports *Sirajganj*, has been referred to as 'a town without houses'. Although even in those days *Sirajganj* was a great trading place but because of shifting market place on char lands, no considerable township was created.

Sirajganj is now situated in the bank of the *Jamuna*. This river frequently changes course. As a result of such changes *Sirajganj* suffered heavily when in 1848 the whole town was swamped. Although a much better site, *Belkuchi*, was available, traders decided to stay at *Sirajganj* in spite of all its disadvantages. *Sirajganj* is one of the most important jute market in Bangladesh. In fact, it is second only to *Narayanganj*, as an inland port for jute.

Sirajganj, previously part of the old (or greater) *Pabna* district is now a district itself. It is an important centre of trade, commerce and industry. It is connected both by rail, road and ferry services with other places of the country. At the completion of the '*Jamuna* Bridge', *Sirajganj* is likely to become even more important.

The Rivers

At the extreme northern point, the *Jamuna* throws off a small offshoot, called the *Kazipur* river which flows South through *Kazipur* Thana and joins the *Ichamati* in *Sirajganj*. The *Ichamati* river enters *Sirajganj* Thana from the North at *Bagbari*, a village near *Dhunot* in *Bogra* district. The combined waters of the *Kazipur* and the *Ichamati* river flow South by a winding course through *Sirajganj* until they fall into the larger river, the *Karatoya*, at *Nalkasenganj*.

The *Dhanbandi (Baral)* starts from the *Jamuna* near *Sanchalia*. It then passes through the town and falls into the *Hurasagar* near *Maupur*. A bridge, 120 feet wide was built over the river in 1892 and is called Elliot Bridge, named after Sir Charles Elliot. This river, very narrow at places, is now used as a dumping ground of urban waste.

The *Kata khal* was a channel cut by an indigo planter at *Sirajganj* for the convenience of boat traffic. This *khal* connects *Daibhanga khal* and *Dhanbandi* river.

The *Jamuna* is a braided stream characterised by a network of interlacing channels with numerous sandbars enclosed in between them. The sandbars or chars, do not, however, occupy a permanent position. The river deposits them one year and very often will destroy and redeposit them in the next rainy season. The process of deposition, erosion and redeposition goes on continuously. Breaking of char or the emergence of a new one is a cause of much violence and litigation in the area.

The *Jamuna* is a very wide river. During the monsoon it is about 8-12km from bank to bank. Even during the dry season, the width is not less than 3-5 km.

The river *Jamuna* has steadily encroached upon its western bank. In 1848, the whole town of *Sirajganj* had to be removed to a new site to the west owing to a change in the course of the river. As reported the portion in front of Dakbungalow and Munshif Court was also eroded away about 80 years back. Since then the town is being protected by an embankment and brick masonry dressing of different thickness. Due to the protective works and the course of time, the river shifted its course towards the East leaving a vast char land. The river started eroding this char land again in 1963.

The protective works constructed for the protection of *Sirajganj* town were damaged by high velocity of current and heavy wave-wash and have from time to time, been reconstructed and retired. A *'Sirajganj* Town Protection Plan' is being prepared and will be executed very soon.

History of natural calamities

Cyclone of 1872: A severe cyclone swept over *Sirajganj* on 20th September. Many government offices were blown down and almost all the records were destroyed. The *Mymensingh-Sirajganj* mail boat sank in the *Jamuna*. Besides, agricultural crops were seriously damaged.

Scarcity of 1874: In this year, rice harvests, both Aus and Aman, were reported to have yielded only half the average. Although the distress did not anywhere approach an actual famine, there were three months of scarcity during which the condition of the people was really critical.

Flood of 1906: In August, 1906 there was a serious flood which affected the whole of *Sirajganj*. Many villages were submerged and roads breached.

Flood of 1968: Five thanas of *Sirajganj* district were affected. Many people were affected including those of the char areas. Large numbers of people were also affected due to the breach of embankment. The brick-built embankment protecting *Sirajganj* town was also partially eroded by the rapid current of the river *Jamuna*.

Cyclone of 1969: On the 17th April 1969, a severe cyclone swept over *Sirajganj*. A total of 32 human lives were lost. Many fruit trees were blown down. Kutcha houses and huts were levelled to the ground.

Flood of 1970: Areas of *Chauhali, Belkuchi, Sirajganj, Kazipur, Shahzadpur* and *Sujanagar* in the district were severely hit by the flood. Much land was inundated. Kutcha houses collapsed in a storm accompanied by a heavy downpour. Many villages disappeared due to erosion by the river *Jamuna* and 50% of the standing crops were washed away.

Breaches of BRE since 1984: Although the CPP area is not as badly affected as the reach to its North, the insecurity and economic devastation of the floods are strongly felt.

2.1.4 Process of sub-compartment designation

Following the criteria set for sub-compartment designation (Section 1.3), *Sirajganj* CPP area has been divided into 9 sub-compartments including one involving *Sirajganj* urban area (Table 2.1). Physical parameters and manageability were considered most.

A flow pattern of the area has been established. Based on the flow-pattern, available contour map and through physical verification, a total of 21 catchment areas were identified. An infrastructure map was developed using aerial photograph of the area and through a number of field visits. The present infrastructures, mainly roads and water ways were used as sub-compartment boundaries (See separate map in the back of this volume).

These sub-compartments may, if necessary, be redesigned and/or subdivided during detailed planning and design, based on the agricultural landuse, social heterogeneity and manageability.

Table 2.1: Sub-compartments areas (ha) in *Sirajganj* CPP

Sub-Compartment	Gross area	Settlement area	Water bodies	Net cultivable area
1	873	101	22	750
2	797	83	5	709
3	1061	160	8	893
4	1371	223	16	1132
5	2012	294	62	1656
6	1455	238	21	1196
7	1283	169	43	1071
8	2319	259	79	1981
9	886	685	10	191
Total	12057	2212	266	9579

Source: CPP computations, using the facilities of DDC.

2.2 Brahmaputra Right E nbankment (BRE)

2.2.1 Background

The BRE is one of the first FCD projects in Bangladesh (FAP 12, 1991). The *Brahmaputra* originates from the northern slopes of the Himalayas in Tibet; its actual catchment area in Banglade h is limited to only 5% of the total catchment area of 520,000 km2.

The annual hydrograph is c haracterized by low flows during the dry season associated with the winter months and high flows during the summer due to snowmelt in the Himalayas and heavy rainfa l in the Assam valley and Bangladesh itself. In most years, the *Brahmaputra* peaks in l te July or early August and some overbank flooding occurs at that time (FAP 12, 1991).

The BRE has been orig inall built at a length of approx. 200km from *Hurasagar* to *Kamarjani* (Figure 2.1) betv een 1957 and 1968. Its main purpose is to limit the extensive flooding by the *Brahmaputr* on its right bank and protect an area of approx. 240,000 ha. The design return period of he BRE was determined at 1:100 years. Initially this approach was succesful, out more recently constant erosion of the banks of the river resulted in frequent breachir g.

It is estimated that the area affected by the 1987 flood is 57,300 sq.km which is 4,750 sq.km more than the area at ected by the 1974 flood (FAP 12, 1991).

The present situation of FAP 20 Sirajganj study area is depicted in Fig. 2.2. The *Jamuna* river course (dry season) shows its preference next to the CPP Sirajganj boundary in the north-eastern part. The 1993 dry season situation coincides with the incidence of the *Jamuna* river course over 2C years (Figure 2.3C). This preferential course has caused severe erosion over the year and has resulted in a number of retired embankments in this section of the BRE.

On the south eastern side of CPP Sirajganj, clear accretion has taken place over the years. The superimposed CPP Siraj anj boundary line on the eastern side excludes all land on the *Jamuna* river side which is a result of land accretion. This accrued land is located on the area between the BRE and the current dry season river bank.

The progressive retirem nt o the BRE demonstrates the severity of the natural bank erosion of the *Brahmaputra* r ver (FAP 2, Main Volume, 1992). From 1975 onwards, major rehabilitation was carr d out. The River Training Studies of the *Brahmaputra* River indicates that (FAP 19, 1993).

> *" .. It appears that the present westward movement of the right bank (of the Brahmaputr) will continue for several decades, probably at a similar rate to that xperienced over the last 35 years; at the same time, the river is be coming steadily wider."*

It is clearly shown (FAP 2, Vol.10, 1992) that the most serious flooding problems occur along the *Brahmaputra* due to breaches in the BRE. That same source mentions that most flooding problems in the BRE affected area can be efficiently eliminated if the BRE can be properly sealed.

Along the entire BRE, the *Kazipur* reach is one of the most unstable sections (FAP 12, 1991). The *Kazipur* reach is a section of the BRE from which the southern boundary overlaps with the CPP *Sirajganj* project area. It is reported that there are frequent breaches and embankment retirements in this section and because the land slopes away from the embankment, the breaches cause severe damage. Most frequently, the number of BRE retirements to date ranges from one to three.

In case a major breach occurs, the CPP project area will be impacted by either floodwater from the area around *Kazipur* or directly from a breach in the CPP BRE boundary area. It is mentioned (FAP 12, 1991) that:

> *"...the embankment section in the Kazipur reach is very poorly maintained and supervised. Due to lack of proper maintenance severe damage occurs to the embankment which jeopardises the stability of the embankment and security of crops, lives and property in the project area (Kazipur reach)".*

Furthermore, actual implementation of planned retired embankment often faces problems which are delaying timely implementation of these embankments. This partially causes also unauthorized settlement of the affected people on the newly constructed embankment which in turn results in poor quality.

One of the most severe floods in Bangladesh occurred in August 1987. One of the affected areas was the Sirajganj area. A comparison between the dry season image of 7 February, 1987 (Fig. 2.3A) and the flood image taken on 18 August 1987 (Fig. 2.3B) clearly identifies the severity of flooding in that area. The *Jamuna* river had in August 1987 (Sirajganj) risen to a water level with a return period of 12 years.

An indication of longterm changes in the *Jamuna* river pattern and hydrological regime can be shown in the incidence of low flow channel over selected periods (1973-1992). During the 20-year period (1973-1992) the preference of the *Jamuna* river has shown at least 7 times to follow the same course near CPP Sirajganj (Fig. 2.3C).

Longterm changes in the *Jamuna* river pattern, its acrretion and erosion locations can be visualized by a snapshot approach whereby the 1973 and 1992 situations are compared (Fig. 2.3D). It is clear that severe erosion takes place on the northern part of the Sirajganj area while the more downstream part of CPP Sirajganj shows accretion. This erosion pattern is part of a gradual westward movement by the *Jamuna* as predicted by the *Brahmaputra* River Training Study. The accretion is probably due to the construction of a number of groynes in the most downstream part of CPP Sirajganj.

2.2.2 Breaches

It has proved difficult (FAP 12, 1991) to build up a reliable history of breaches. Relevant information regarding breaches and its impact on the affected area is not readily available from the BWDB. It is assumed that the first retirements took place in the vicinity of *Kazipur* around 1975, only approx 10 years after the original construction. The problem became more significant in the early 1980's. It is clear that the problem is becoming more serious over the past 5 years as progressively more of the BRE becomes within range of aggressive bend erosion.

For the *Kazipur* reach, embankment breaches since 1984 have caused serious flooding in 3 out of 5 years. For the *Sirajganj* CPP area, several breaches have occurred at several locations along the BRE. (Figure 2.4).

The flooding due to breaches and overtopping has seriously reduced the scope for monsoon crop intensification, which require a controlled water regime. Two types of measures are feasible in order to control the uncontrolled flooding situation:

- RETIRED EMBANKMENTS
- PROTECTIVE WORKS

2.2.3 Retired embankments

It is the task for the BWDB to construct, operate and maintain the BRE, in order to keep the area from unwanted flooding. Any damage should be assessed and realignment be put forward by the BWDB and implemented. The present practice in case of breaches is that new alignments will be identified by the BWDB (O&M SECTION) and subsequent retired embankments implemented after land acquisition has taken place.

2.2.4 Protective works

The construction of protective works is one of the measures to protect or stabilize a reach of a river. Both groynes and revetments have been used (FAP 12, 1991). If groynes are the preferred solution then they are normally provided in a series and are often laid out with opposing sets on both banks in order to encourage the formation of a single channel. Only two groynes (Figure 2.4) have survived: at *Sariakandi*, the groyne was constructed in 1986/1987 and upstream of *Sirajganj* the *Ranigram* groyne was completed in 1985 to provide additional upstream protection to the existing revetment stabilizing the bank in the immediate vicinity of *Sirajganj* town.

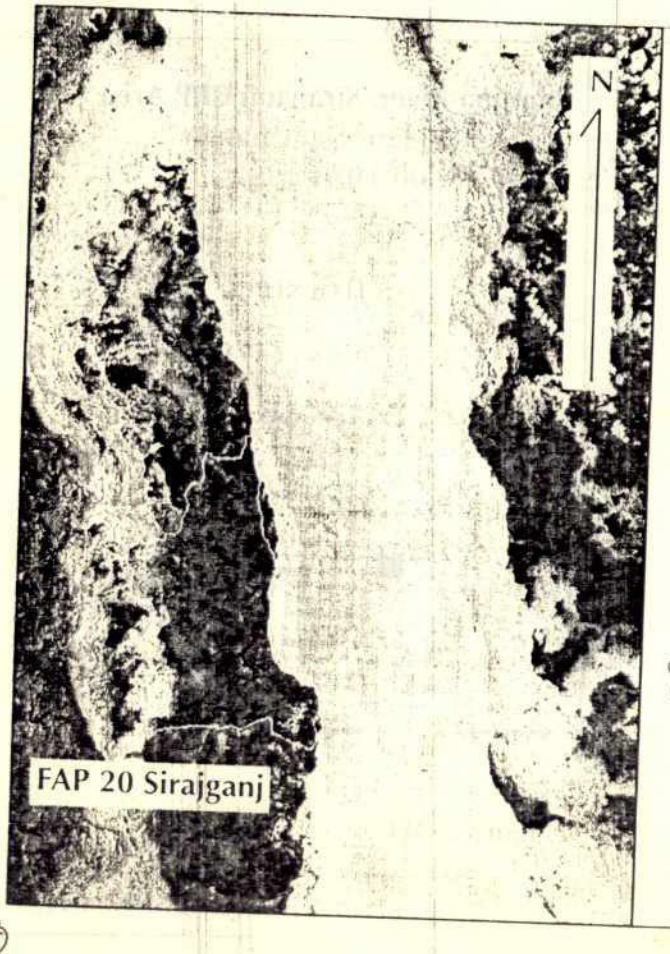
However, based on the existing situation (frequent breaching occurs) and perceived development in the coming years, assurance is given by the BWDB that the sealing of the BRE at the CPP *Sirajganj* project area reach will come into effect shortly. Improvements at the *Kazipur* reach have not yet been confirmed. Especially at the CPP project area, severe problems occur at a number of sites. The maintenance and repair of these currently deficient sections of the BRE by the O&M section of the BWDB, however, is not sufficient to guarantee that breaching of the BRE by erosion will not occur any more in the future.

Jamuna River, Sirajganj CPP Area
Febr. 1987 dry season.

0 5 10 15 km
SCALE

Figure 2.3A

Source : Landsat MSS processing by ISPAN/FAP 19

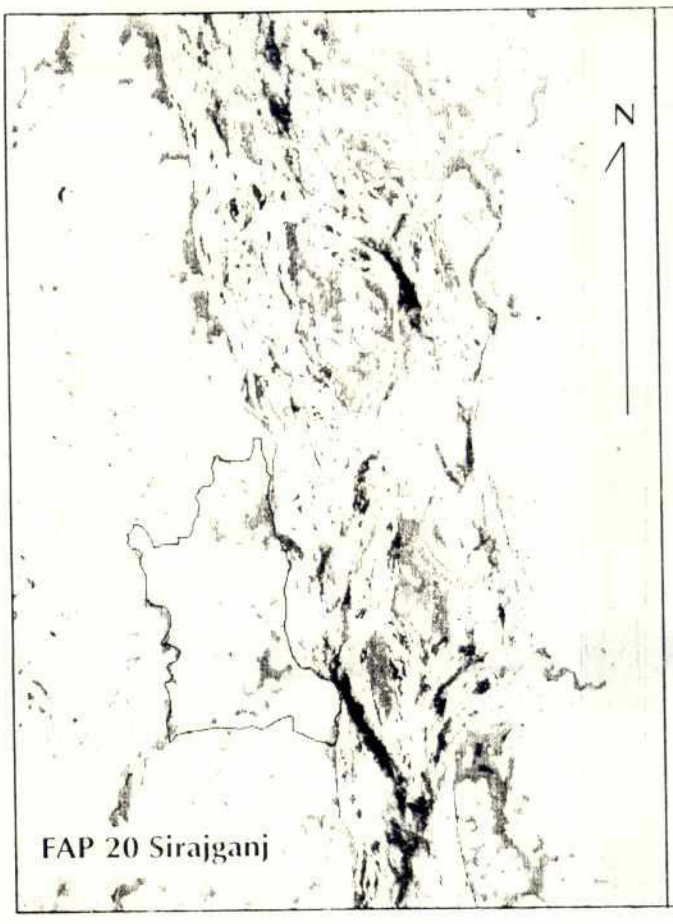


Jamuna River, Sirajganj CPP Area
Aug. 1987 Flood Extent.

0 5 10 15 km
SCALE

Figure 2.3B

Source : Landsat MSS processing by ISPAN/FAP 19



Jamuna River, Sirajganj CPP Area
Incidence of Low Flow Channel over Selected Periods, 1973-1992.

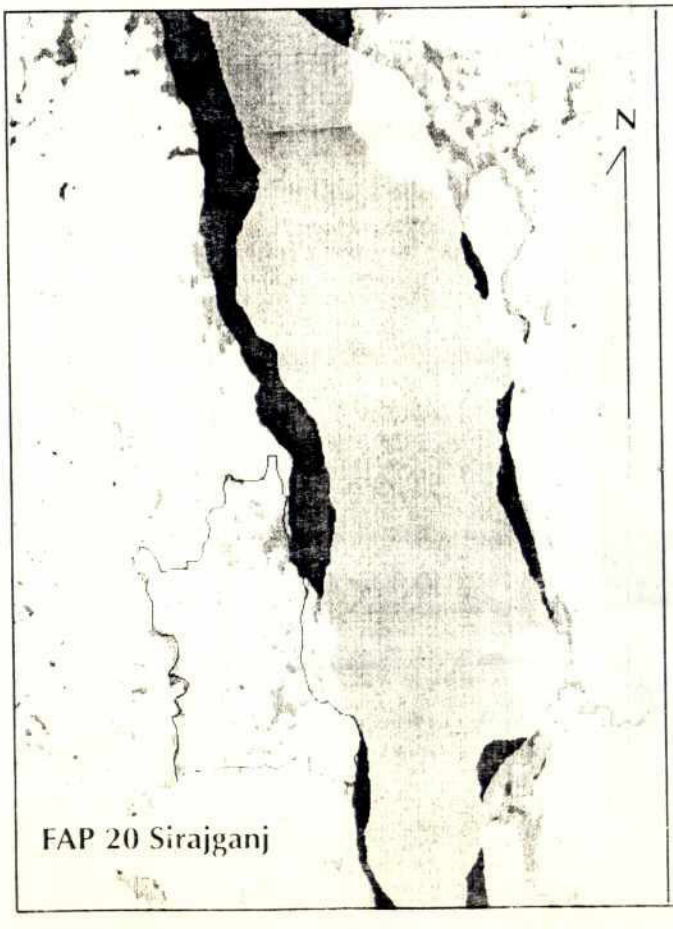
LEGEND
NUMBER OF DATES CLASSIFIED AS CHANNEL

1 Date
2 Dates
3 Dates
4 Dates
5 Dates
6 Dates
7 Dates
8 Dates

0 5 10 15 km
SCALE

Figure 2.3C

Source : Landsat MSS processing by ISPAN/FAP 19



Jamuna River, Sirajganj CPP Area
River Bankline Net Change Over Period 1973-1992

LEGEND

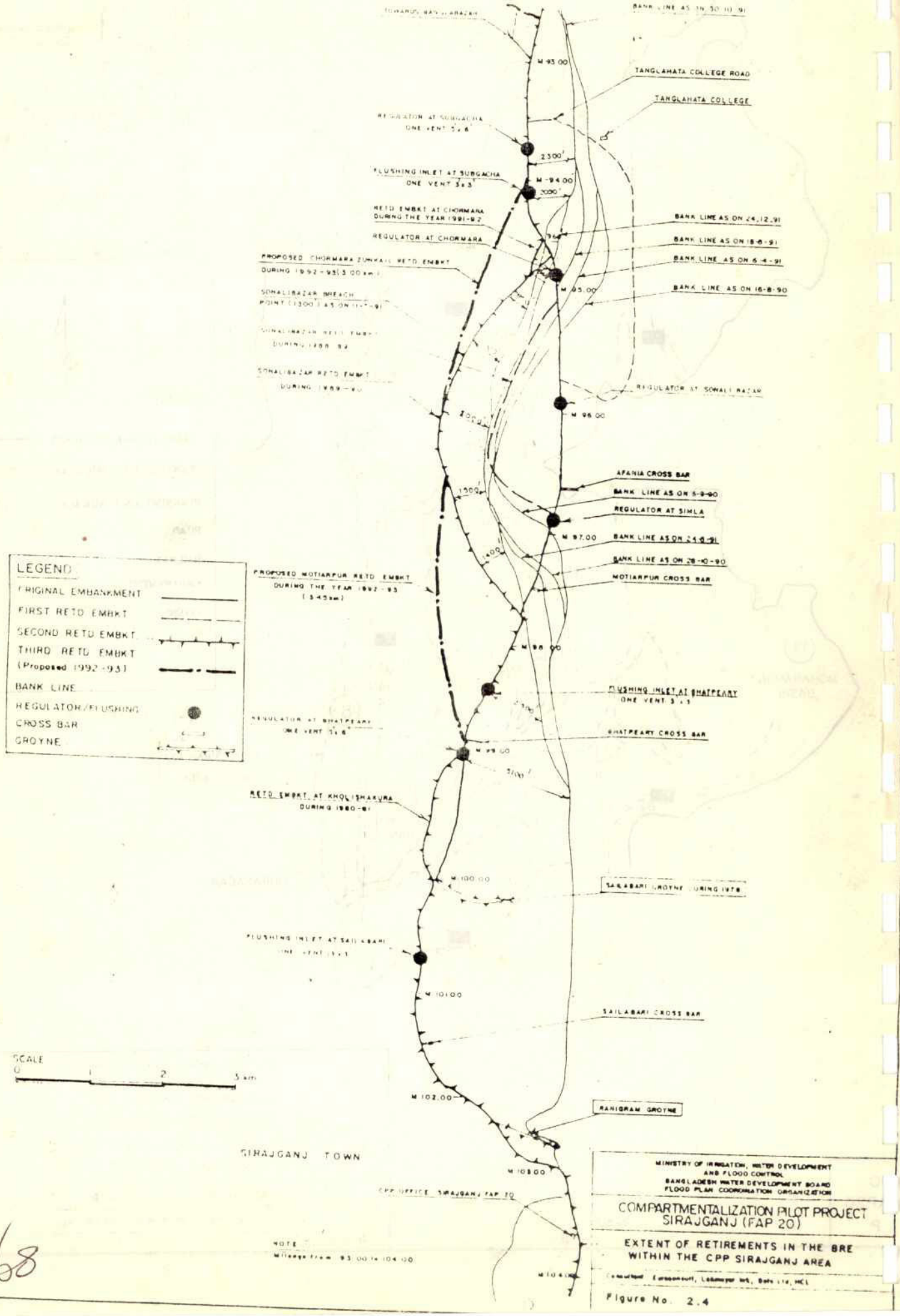
NUMBER OF DATES CLASSIFIED AS CHANNEL

1 No Change
2 Accretion
3 Erosion

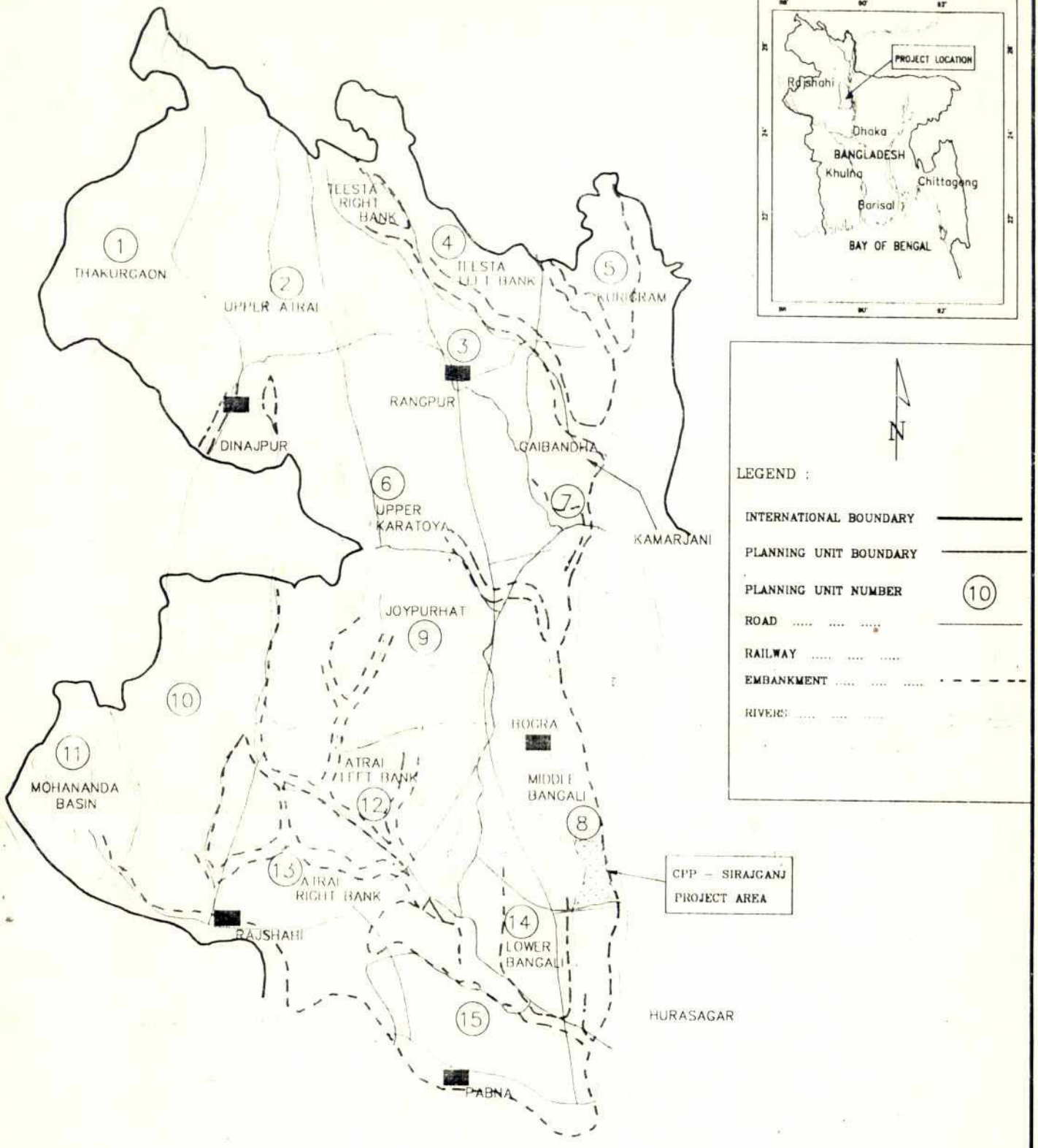
0 5 10 15 km
SCALE

Figure 2.3D

Source : Landsat MSS processing by ISPAN/FAP 19


BANK LINE AS ON 30.10.91
M 93.00
TANGLAHATA COLLEGE ROAD
TANGLAHATA COLLEGE
REGULATOR AT SUBGACHA
ONE VENT 3 x 3
2300'
FLUSHING INLET AT SUBGACHA
ONE VENT 3 x 3
M 94.00
2000'
RETD EMBKT AT CHORMARA
DURING THE YEAR 1991-92
BANK LINE AS ON 24.12.91
REGULATOR AT CHORMARA
BANK LINE AS ON 18-6-91
BANK LINE AS ON 6-4-91
PROPOSED CHORMARA ZUNKAIL RETD EMBKT
DURING 1992-93 (3.00 km)
M 95.00
BANK LINE AS ON 16-8-90
SONALIBAZAR BREACH
POINT (1300') AS ON 11-7-91
SONALIBAZAR RETD EMBKT
DURING 1988-89
SONALIBAZAR RETD EMBKT
DURING 1989-90
REGULATOR AT SONALIBAZAR
M 96.00
2000'
APANIA CROSS BAR
BANK LINE AS ON 5-9-90
1500'
REGULATOR AT SIMLA
M 97.00
BANK LINE AS ON 24-9-91
1400'
BANK LINE AS ON 28-10-90
PROPOSED MOTIARPUR RETD EMBKT
DURING THE YEAR 1992-93
(3.45km)
MOTIARPUR CROSS BAR
M 98.00
FLUSHING INLET AT BHATPEARY
ONE VENT 3 x 3
REGULATOR AT BHATPEARY
ONE VENT 3 x 3
BHATPEARY CROSS BAR
M 99.00
2700'
RETD EMBKT AT KHOLISHAKURA
DURING 1980-81
M 100.00
SAILABARI GROYNE DURING 1978
FLUSHING INLET AT SAILABARI
ONE VENT 3 x 3
M 101.00
SAILABARI CROSS BAR
M 102.00
RANIGRAM GROYNE
SIRAJGANJ TOWN
M 103.00
CPP OFFICE, SIRAJGANJ FAP 20
M 104.00
LEGEND
ORIGINAL EMBANKMENT
FIRST RETD EMBKT
SECOND RETD EMBKT
THIRD RETD EMBKT
(Proposed 1992-93)
BANK LINE
REGULATOR/FLUSHING
CROSS BAR
GROYNE
SCALE
0 1 2 3 km
NOTE
Mileage from M 93.00 to 104.00
MINISTRY OF IRRIGATION, WATER DEVELOPMENT AND FLOOD CONTROL
BANGLADESH WATER DEVELOPMENT BOARD
FLOOD PLAN COORDINATION ORGANIZATION
COMPARTMENTALIZATION PILOT PROJECT
SIRAJGANJ (FAP 20)
EXTENT OF RETIREMENTS IN THE BRE
WITHIN THE CPP SIRAJGANJ AREA
Figure No. 2.4

68



MINISTRY OF IRRIGATION, WATER DEVELOPMENT
AND FLOOD CONTROL
BANGLADESH WATER DEVELOPMENT BOARD
FLOOD PLAN COORDINATION ORGANISATION

COMPARTMENTALIZATION PILOT PROJECT SIRAJGANJ (FAP 20)

CPP – SIRAJGANJ WITHIN NWRS PLANNING UNITS

Consultant: Euroconsult, Lahmeyer Int., Beta Ltd., HCL

Figure No. 2.1

C
AP20
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2.2.5 Involvement of other FAPs

The complexity of the *Jamuna* river and its impact on the region involves directly or indirectly a number of FAP-projects.

FAP-1:	*Brahmaputra* Embankment Strengthening
FAP-2:	NorthWest Regional Study
FAP-12:	FCD\I Agricultural Review
FAP-13:	O&M review
FAP-17:	Fisheries Study and Pilot Project
FAP-19:	Geographic Information Systems
FAP-20:	Compartmentalization Pilot Project
FAP-21/22:	River Training
FAP-25:	Flood Modelling/Management Project

The present status of the BRE in a number of crucial places, urges for an integrated and consistent approach whereby decisions are taken at national/regional level for stabilization of the BRE.

2.2.6 Flooding

The stochastic feature of flooding from the *Jamuna* and the BRE breach occurrence due to erosion brings the feasibility and viability of the CPP to one important and basic question: How can such unwanted flooding be prevented?

The flooding may be caused by :

1) a local BRE breach on the boundaries of the *Sirajganj* compartment;
2) a BRE breach in the upstream part of the *Sirajganj* compartment;
3) major runoff as a result of local rainfall upstream of the CPP *Sirajganj* project area;
4) backwater (or backflow) effect from the Karatoya river back into the Ichamuti river;
5) any combination of the above four.

2.2.7 Fisheries

One of the negative consequences of the BRE is the serious decline in open water capture fisheries (FAP 12, 1991):

i. The blockage of fish migration routes to and from the rivers and beels, reduction of fish spawning areas and restriction of migration by the major carps.
ii. Reduction of the inundated floodplain area.
iii. Annual flooding due to breaches of the embankment, limiting the scope for pond culture.

2.2.8 Concluding remarks

The *Sirajganj* compartment is situated behind the *Brahmaputra* Right Embankment (BRE) and therefore largely depends on the quality of the BRE. Protection from the *Brahmaputra* flood is assumed to be provided by the BRE. At compartment level, the water management is to be developed in a protected situation. As part of this planning exercise which forms the basis for future elaboration, design and implementation it is necessary to identify a number of options which are amongst the most feasible to implement within the project framework. Taking into account the overall likely development of other controlled flooding and controlled drainage projects in the region, agricultural, hydrological, economic and social aspects are to be consistently identified and weighted in these scenarios. Although at this time it is not possible to weigh these factors in a consistent framework, the importance of these factors should be estimated in general terms.

2.3 Climate

The *Sirajganj* Compartment is situated within the drier region of Bangladesh with generally extreme temperatures, less rainfall and with aridity index of <0.50 for six months between November to April (Table 2.2). Mean annual rainfall is 1779 mm with 90% falling in the months between May to October.

Table 2.2: Climatological parameters of the CPP area, Sirajganj

Mean altitude : 12-50 m				Longitude : 89.37-89.43°E						Latitude : 24.26-24.37°N	
Month	Temperature (°C)				Sunshine (hrs./day)	Wind speed (km/hrs.)	Rain fall (mm)	Humidity (%)		Evapo trans-piration (mm)	Aridity Index*
	Mean		Absolute					9 a.m.	6 p.m.		
	Max	Min	Max	Min							
January	25.1	11.7	30.6	5.0	8.7	3.0	8	77	68	96	0.08
February	28.2	13.4	35.0	7.2	9.2	3.3	14	71	55	119	0.12
March	32.6	17.9	40.6	11.1	8.7	5.0	31	67	44	179	0.17
April	35.3	22.1	42.8	13.3	8.4	7.6	94	71	41	208	0.45
May	33.6	24.3	42.8	17.8	8.5	8.4	239	79	61	199	1.20
June	31.6	25.3	37.9	20.6	4.3	7.4	344	85	81	147	2.34
July	30.9	26.0	40.0	21.7	5.0	7.0	352	86	85	146	2.41
August	31.1	26.4	39.4	23.3	4.9	6.0	278	85	84	140	1.99
September	31.3	25.9	38.3	21.7	6.9	4.8	251	84	85	135	1.86
October	30.9	23.4	37.2	17.2	7.6	3.2	139	79	81	105	1.32
November	28.5	17.8	33.9	10.6	9.0	2.3	20	75	76	105	0.19
December	26.3	13.6	31.7	7.2	8.8	5.8	10	76	75	90	0.11
Annual							1779				

Source : Temperature, Sunshine, Wind speed, Humidity: Manalo, E.M.; Agro-Climatic Survey of Bangladesh, BRRI/IRRI, 1976. Based on >70 years of data between 1902-1974 of Bangladesh Water and Power Development Authority.
Rainfall, Evapotranspiration: FAP-2 (1993). Draft Final Report, Volume-10, Hydrology and groundwater. Based on 28 years data of period 1962-1990.
*Aridity Index : Classified "dry" when the reading is < 0.50.

The critical aspects of climate in relation to crops are:

- the occurrence and reliability of the early monsoon rains and the onset of the monsoon.
- the occurrence of storms that damage standing crops (Boro, HYV rice).
- the reliability of the monsoon rains, and the rise, duration and recession of floods associated with the monsoon rains; and
- the reliability, amount and distribution of the late monsoon rains.

2.4 Reconnaissance and preliminary survey

The objective of the preliminary survey of the *Sirajganj* compartment was to get an overview of the situation prevailing in the area. This survey formed the basis of planned detailed surveys.

For this preliminary survey, secondary data sources were extensively used. Where possible, the information base was broadened and checked through interviews and field visits.

Some findings are included in the various subject sections. Other key-figures are summarized below:

- Breaches on the BRE occur frequently since 1984. These occurred in areas of *Simla Bazar, Khoksabari, Bhatpeari, Matiarpur, Sonali Bazar, Chormara, Subhagacha and Banglabazar* of the CPP project area. *Simla Bazar* and *Sonali Bazars* are completely wiped out and the *Jamuna* is now near *Par Simla.*
- Four different soil associations are found. Kamarkhanda-Silamandi-Savar bazar association having silty loam to silty clay loam soils are predominant.
- In some places BRE appears to be narrow, weak and not well compacted, being vulnerable to erosion and subsequent breaching at any time.
- Along most of the BRE settlements of erosion victims have sprung up, cutting the embankment crest and slopes into terraces, thus weakening the embankment.
- In several places BRE has been retired, and new embankment stretches have been constructed. Due to lack of clay, most of the newly constructed embankment stretches have been done with very sandy soil, with little or no compaction.
- Agriculture in *Sirajganj* CPP mainly depends on the perceived reliability of the BRE to provide protection.
- With breaches occurring farmers shifted their agricultural activities to the dry season utilizing ground water irrigation.
- With sand layer deposits carried in by the *Jamuna* floods, sugarcane is extensively grown, mostly intercropped. Two or three other crops in a sugarcane field are common.
- Areas under Jute is decreasing. Farmers harvested a good T.Aman crop in 1992 after 6-7 year of total or partial crop failure. The areas under Aus is negligible.
- There are 3 rivers, 6 canals, 3 perennial beels, 6 seasonal beels, 330 ponds, a vast floodplain and a good number of road side ditches and pagars in the project area.
- The area has a substantial number of subsistence fishermen i.e. farmers and landless who capture fish mainly for home consumption.
- There are about 800 professional fishermen households and five registered *Matshayajibi* Samities (fishermen's cooperative) with a total of 410 members.
- Aquaculture in the area is, for various reasons, not well developed.
- Livestock in the area seems to follow the national trend, i.e. reductions in the number of cattle and an increase in poultry and goats.
- The wage rate of agricultural labourers varies between Tk.25/- to Tk.40/-, in most cases without a meal.
- Weavers, bidi and mat makers form important traditional professional groups. Both male and female workers are engaged.

- *Sirajganj* is an important centre of trade, commerce and industry. Apart from Quami Jute Mills Ltd. and *Sirajganj* Spinning and Cotton Mills Ltd., there are two Jute bailing presses, soft drink factory and some small scale rice and flour mills. The communication within the area is mainly with Kutcha roads. A paved *Sirajganj-Kazipur* road runs through the middle of the project. *Sirajganj* is connected by road, rail and river ways with other places of the country.
- The position of women is similar to women in other areas of Bangladesh. A number of NGO's activities and programmes are related to women group as:
  a) to facilitate women's groups for organising and utilizing their own savings.
  b) motivation, training and education programmes.
  c) family planning, child and mother health care support.
  d) to organise and create social awareness regarding violence against women, family laws, divorce, early marriage and women oppression.
- Diarrhoea is reported to be prominent. There are 3 hospitals of 135 bed-capacity, 4 family planning clinics, one eye-hospital and one Diabetes Centre. NGO-run child and mother health care centres are also found.
- There are a number of NGOs working in the area. BRAC, Proshika, CARE are prominent. ICDDR-B has projects in the area. Local NGOs, *Dip Shetu* and *Uttaran* work in specific areas.
- *Sirajganj* BRDB has a list of 321 cooperatives. The total number of members in these cooperatives is about 2[illegible],000.

2.5 Baseline surveys framework

2.5.1 General

The pilot project nature of FAP 20 calls for an experimental type of approach to project design and implementation. FAP 20 therefore needs both detailed and extensive information on the existing and, in due course, on the post-project situation. To gather this information FAP 20 conducted a rather comprehensive **baseline survey**, consisting of six specific surveys, each with specific objectives:

- The **household survey** is designed to provide statistically valid baseline data mainly covering social, economic and agricultural issues. The survey is of the questionnaire type. This data has been used to some extent in the planning process and in the multi criteria analysis of the alternatives. The main use will be in the ex-post evaluation.

- The **topographic and hydrological surveys** provide vital information for the planning, the mathematical modelling and the post-project evaluation. This survey includes levelling, recording water levels and discharge measurements.

- The focus of the **needs assessment survey** is in the interrelation between all the relevant facets of life in both inside and outside the compartment. Typical items are hydrological situation, environment, transport, fisheries, rural industry, agricultural status etc. Data was collected using a Rapid Rural Appraisal approach. An emphasis

was given to identify water related needs, problems and possible local solutions. The main use of the information is in planning and design. At the post-project evaluation stage, the data will again prove useful as qualitative, descriptive baseline information.

- The **land-use survey** aims at getting a detailed picture of the way land in the area is used, with particular attention for the agricultural use. Information on cropping patterns, crop varieties and other inputs used etc. are collected.

- The **irrigation survey** aims at obtaining a complete picture of irrigation sector development. This provides accurate estimates of number and type of minor irrigation equipment, energy source, use of engine, and crops under irrigation.

- Through the **institutional survey**, information is gathered at the compartmental level regarding the institutions relevant to water management. The information has been gathered using open ended checklist questionnaires. The data is fed into the design and implementation of the institutional development.

On the basis of the outcome of the baseline survey a **monitoring programme** is designed which measures key indicators on a regular basis throughout the project lifetime. The data are used for intermittent and post-project evaluation.

Finally, the project calls for in-depth **special studies** to supplement the broad surveys. The reason is that there are areas, relevant to compartmentalization, where existing practices are clearly in-effective, as well as areas about which little is known and/or where there are few if any solutions. The baseline information is used to up-date the tentative list of special studies.

2.5.2 Household survey

The data collection of the Household Survey took place from mid January 1992 till the end of April 1993. The areas surveyed comprised, besides the compartment itself, the adjacent areas and a control area *(Kazipur Thana*, in as much as it did not fall within the adjacent area. The work has been performed by the Multidisciplinary Action Research Centre (MARC) a firm which is specialized in this type of work.

Some of the conclusions of the survey are:

- of all the rural households 32% operate a farm of 0.2 ha. or more, implying that just under 70% of the households depend on non-farm activities;
- the distribution of households over the different farm size categories, and the area cultivated per category is as follows;

	Pure share cropper	Marginal farmer	Small farmer	Medium farmer	Large farmer
% of farm households	5	28	38	24	5
% of land cultivated	2	16	33	36	13

- land values show an irregular pattern, with medium farmers buying most and small farmers selling most land;
- consumption (34%) and the need to raise cash (15%) are the reasons most often mentioned for selling land, while marriage/dowry scores at 10%;
- the literacy rate is highest among the urban people (male 66%, women 53%), lowest amongst fishermen (male 16%, female 10%) while farm households (35%) are almost 50% more literate than non-farm households (24%), and only non-farm women (14%) are only half as literate as farm women (28%);
- the mean number of days employed is highest in the urban households (319), lowest for fishermen (300) while farm and non-farm register a mean of 309 and 312 days employed;
- on average one third of credit taken comes from institutional sources with non-farm households taking half their credit and fishermen households all their credit from non-institutional sources;
- farm and urban households take about the same amount of credit, fishermen households two-thirds of that, and non-farm households one third;
- members of fishermen households have the highest level of cooperative membership (36%) with urban households scoring a low 4%;
- only about 2% of the farm and non-farm households have a member who is related to an NGO, while none of the sample fishermen nor urban households reported such involvement;
- child mortality (on average just over 25%) is highest amongst fishermen households, followed by farm, non-farm and urban households;
- the male-female ratio at 107 is close to the national average, but rather more unbalanced for farm households at 116, and balanced at 99 for non-farm households;
- the fish epidemic started in 1988, peaked in 1989 and the situation has improved since then.

For more information see Annex 8, and for more details its Appendices.

2.5.3 Topographical and hydrological survey

Topographical data are the essential part of any planning analysis. Extensive survey were carried out to get topographical information. Apart from measured water levels at specific locations within the CPP area, many of the water level data were collected from the BWDB Hydrology Department, especially from outside the CPP area.

2.5.3.1 Topographical Survey

The topographical data consists of river cross-section, contour levels for the entire area and plan layout of the channels, floodplain and homesteads.

Sirajganj compartment a topographical survey was carried out during the 1991/92 dry season. Covering the objective of this survey was to measure the existing infrastructure. In this survey, total 100 km of longitudinal profile of river, 92 river cross-sections and 18 existing structures were surveyed. Apart from this long profile of 83 km of road of which

19.50 KM of *Brahmapura* Right Bank Embankment (BRE) and 23.05 km of *Sirajganj-Kazipur* road were also surveyed. Details of this survey are shown in Annex 3.

For contour levels, 1964 8 inch-to-a-mile map is used. The latest contour maps prepared by FAP18 for the *Sirajganj* compartment became only available during printing of this report.

Also for the study, 1:20,000 satelite images in combination with 1:50,000 Spot images were collected and used.

The river system in the *Sirajganj* compartment (including *Brahmaputra*) changes location considerably over the years. In order to get the exact position of the river, embankment, road, a GPS (Global Positioning System) Survey was carried out. The maps were updated with the help of GPS measurement and processed by GIS (Geographical Information System).

2.5.3.2 Hydrological Survey

The following hydrological data are collected/measured:

* Rainfall
* Surface water data
* Groundwater
* Evaporation

For the mathematical modelling and other analysis, *Sirajganj* station daily rainfall data were collected from 1965 to 1992.

There are 19 water level gauges installed both inside and outside the project area. These are used to calibrate the mathematical model. Out of these, 3 gauges are linked with an automatic water level recorder. Apart from these water level stations, 4 BWDB water level stations (*Dhunot, Nalkasengati, Sirajganj and Kazipur*) were collected (1965 to 1990). *Dhunot* data are used for selecting the design embankment level. For this purpose the *Dhunot* water levels are analysed to determine 1:2, 1:5, 1:10 and 1:20 years return period for specific periods of the year.

Also the discharge data on *Ichamati, Bangali* and *Korotoya* were collected. A location map of these stations are shown in Annex 3.

In order to asses the ground water level variation and the impact of the with project situation, data from 4 groundwater stations were collected for the period 1985-1992. The stations were *Dhanbandi, Harina, Sialkoal* and *Tanglahat*. Also, data from 7 groundwater stations were collected from BADC (Annex 2).

For evaporation figures data from the meterological station in *Bogra* were used. Because of the poor quality of available data the *Sirajganj* data were not used. These data are collected and used for the mathematical modelling and crop water requirements.

2.5.4 Needs Assessment Survey

The findings of the survey as expressed by the people can be summarised as follows:

Hydrology

The project area has experienced floods since 1984 from the *Jamuna* by breaching due to erosion of the BRE. The results are disastrous for all concerned, but particularly for those living close to the BRE; whose villages may be washed away. Such floods result in considerable loss to both public and private property, and cause extensive disruption to life.

One of the lasting results of such sudden flooding is partial and at times total silting up of the beds of internal channels and rivers. This, combined with the flooding, in turn results in water logging during the monsoon and post monsoon period. At the end of the dry season the silted up channels no longer carry any water, thus aggravating the drought prone situation.

At times the river *Ichamati* overflows, and people have expressed concern about this. There is widespread agreement among the people in the area about the need to secure the BRE. Many have said that they believe that groynes are the solution to stop the river *Jamuna* eroding the BRE. Many have suggested that the BRE should be provided with regulators to allow controlled flooding.

Some have suggested that existing roads have to be improved to allow year round road communication and a certain level of flood protection. Drainage structures, re-excavation of channels and rivers, regulators and bridges have been requested at specific places.

Farmers

The present insecurity of the BRE is the main concern of farmers. The floods caused by such breaches (inside and outside the project area) have caused significant damages to crops. Farmers stated that other effects are the high mortality rate of livestock and poultry due to shortage of straw and grazing land and lack of access to medicare facilities and high percolation rate of water due to sand deposits following breaches.

Farmers suggested stabilizing the BRE by constructing a series of groynes (which they consider indispensable to stabilize the BRE), providing sluices on the BRE for controlled flooding (except the farmers in low lying areas who were opposed to this), re-excavation of the *Ichamati* and all internal channels, development and construction of internal roads with necessary culverts and regulators and construction of an embankment at some places on the left bank of the *Ichamati*.

The *Ichamati* left embankment may adversely affect the people living on the other side of the river *Ichamati*. Another problem is that time and again existing embankments have failed and farmer's lack of confidence in the executing agencies. Many people suggested that it is important to make the BRE more secure before other developments are taken up.

Fisheries

Ever since the construction of the BRE, which had (has) only a few sluices, capture fisheries declined significantly. More recently (beginning in 1984) when the openings of the sluices and the connecting channels were gradually blocked due to siltation caused by floods, the migration routes of the hatchlings got closed and their nursing area has been reduced considerably. This has resulted in the almost total extinction of capture fisheries of the floodplain. Whatever hatchlings enter the project area in flood years are caught and removed by fishermen because of fish shortage.

Since the 1988 flood, fish disease has created an alarming situation for beel and pond fish. Culture fisheries is limited. The main reason is the sandy soil texture, causing a high infiltration rate. Fishermen suggested that deep and wide sluices should be constructed on the BRE at all the entry points of the *Jamuna* branches to allow migration of hatchlings. They also suggested re-excavation of all internal channels with the provision of deep ditches at certain places on the channel beds to allow grazing by and protection of the hatchlings.

Women

Since 1984 bank erosion of the *Jamuna* and breaching of the BRE have posed a serious threat to the women in the area. According to many women the insecurity caused by sudden breaching of the BRE and the resulting floods aggravate the already bad, existing situation.

Women have mentioned the following flood related problems in particular: increase in rural unemployment, reduction of labour wages, chronic food crisis, lack of drinking water, high prices of agricultural produce and consumers goods, destruction of village roads, houses, market places and educational institutions, illiteracy, suppression of rural women (dowry, divorce, polygamy), inaccessibility of government agencies, post flood epidemics, female and child diseases, lack of medicare facilities, lack of support of UP authorities, increasing in-migration and landlessness.

To overcome these problems the women have suggested to take measures against erosion of the BRE. Many women have said they think groynes are the only way to protect the BRE. They have also suggested building regulators to allow for controlled flooding of the area. Tubewell, improved roads, medical care and other government services have also been suggested.

Non-farming

Bank erosion of the *Jamuna* and breaching of the BRE have seriously worsened the situation of the non-farming people in the area. According to many the insecurity caused by sudden breaching of the BRE and the resulting floods aggravate the already bad, existing situation.

Lack of employment opportu ities in agriculture and services are a major constraint for the non-farming households. To improve this situation many have suggested to strengthen the BRE, protect it with groy es and build sluicegates to allow controlled flooding. Furthermore road improvement and building of culverts and bridges has been suggested as a way to improve the exist ng situation.

2.5.5 Landuse survey

The main objectives of the su vey were :

- to obtain a det ailed picture of the way land in the project area is used for crop production.
- to know about the p resently practised cropping patterns, crop varieties used, yield level of crops area covered with different crop of 100% of the net cultivable area.

The information obtained is : eported separately in Annex 4 and was the basis for developing a base situation re orted in Section 2.9.

Main findings are:

- About 80% of the g oss area is available for cultivation.
- Agriculture in the a ea is predominately based on lift irrigation which has expanded in recent ears.
- At least 27 different cropping patterns are practiced. 10 different patterns cover more than 90% of t e NCA.
- Boro (HYV) - T. A nan pattern occupies the most area.
- Sugarcane is the sin le most important non-rice crop grown over a large belt along the BRE or *Ic amati* and *Doibhanga* rivers. Sugarcane is usually intercropped with at least another crop of pulses, mustard, potato etc.
- B. Aman or DW Ar an is non-existent in the CPP area.
- 1992 was a flood fr e year. In flood years, T.Aman both local and HYVs are affected.

2.5.6 Survey on irrigation

With expanding role of private sectors in the sale and maintenance of irrigation equipment, traditional source of information such as BADC, no longer provides a complete picture of developme its in the irrigation sector. A survey was carried out with the objective to obtain acurate estimates of:

- the number and type of mi ior irrigation equipment used in the Boro season,
- area under irrigation,
- energy source and consum tion of equipment in use,
- the incidence of equipment not in use,
- age and life expectancy of he equipment in use, and
- use of engines for purpose: other than powering irrigation pumps.

Detailed result of the survey is reported in Annexure 4.3 of Annex 4. The main findings are:

- STWs are spreading at a faster rate, however, without substantial increase in area under irrigation.
- STWs and LLPs are powered with diesel more frequently.
- individual ownership of STWs and LLPs predominate.
- DTWs were installed before 1984 and STWs installation started during '80s.
- large numbers of DTWs are idle and probably will never be operational again.
- command area for individual DTW is much lower than expected or potential because of malfunctioning. STW's are taking over.
- electricity cost per hectare irrigated area is about 1/3 to 1/2 of diesel fuel costs.
- electricity is available in 101 villages within the CPP area. Use of this facility is not maximum due to uncertain and irregular supply of electricity.
- use of diesel, though costly in operation, provides the security of power supply.

2.5.7 Institutional survey

In the total *Sirajganj* district, CPP area involves *Sirajganj*, *Raiganj*, *Kazipur* and *Kamarkhand* Thanas. Within these 4 Thanas, only 11 unions(including *Pourashava*) falls under the project and the village coverage is 125 (27 partly and 98 fully).

Objectives of the survey also covered the present strength of the departments/agencies, their involvement with water management, suggestion for future planning and design of the CPP, co-operation aspect and institutional frame for a future project.

Findings of the survey, in short, are as follows :

Government Departments:

Departments like DAE, BRDB, BADC, Fisheries, Livestock, LGED etc. in *Sirajganj* have their own establishment (office accommodation) at district level, except Fisheries.

The mentioned departments know about CPP in general and expressed their willingness to be associated with the project more effectively.

DAE

The Department of Agriculture in Sirajganj is well equipped, sufficiently manned and well established. Water had not been a problem in the last year as reported. The role of DAE has been in the form of advising the farmers and demonstrating of different crops in the field.

All the thanas, unions and villages are covered by the department and extension workers are posted as per requirement. However, extension services is not sufficient enough due to lack of proper inputs from the department itself and other supporting agency viz. BADC. The DAE in *Sirajganj* is willing to take any desired initiative due to the

implementation of CPP and n that situation plans and budgets will be reviewed as opined by the senior officials.

Departmentally the DAE ma ntains working relation with BRDB, BADC, Livestock and the DOF. All these departm nts are member in the DTC. Block Supervisors have been following the T & V system to contact the farmers. The new system of covering all the farmers in the area is still la cking central guidelines. BRDB, KSS groups are in contact where irrigation groups are operated.

DAE was found aware of th possible CPP interventions in the area and for the future institutionalization of benefi iaries, DAE could play the central role as opined by the department. Appreciating th probable CPP interventions in the area it was mentioned that implementation of CPP perh ips could integrate irrigation and agricultural development in the area.

BRDB in *Sirajganj* was fou d to be more eager to be associated with CPP. Both DAE and BADC were appreciatin the probable CPP interventions in the area and were of the opinion that implementation of CPP perhaps could integrate irrigation and agricultural development in the area.

BADC in *Sirajganj*, is being scaled down as all over the country. Services from BADC to farmer's group or individual have been limited to support services as or when called for. DTWs are under utilized co pared to STWs due to technical and managerial reasons.

Fishery department, is facin serious troubles in terms of inadequate technical inputs, limited financial allocation, requent disputes between the fishermen and local musclemen. Professional fishermen have to face unnecessary competition with the middle men at the time of tender for *jalmahals* resulting lease amount almost double. To meet such competition, fishermen need compromise with the middle men. Recommendations from the Fishery department do n t works always. Despite all soft corner for the fishermen from the administration, it i not always possible to secure their interest.

The Department of LGED w as found active in most of the area in the area. It was expressed that LGED is pre ared to take any assignment for the government, even related to water management. They have already planned for different schemes amounting Tk. 2.97 crore covering embank ents, sluice gates, cross dams, canal digging, culverts and rural roads maintenance in S *rajganj* Thana under ADB Programme (1993-94). This department is already anchor ed in Local Government.

The BWDB (O&M division) in *Sirajganj* is responsible for BRE including the town protection. Public demand a d requirements are met by the civil administration (referred to LGED).

Non-Governmental Organi ations:

As many as 7 NGOs are wo king is the Project area. BRAC, Proshika and the Grameen Bank are national CARE Int rnational and BURO *Sirajganj*, Uttaran Mohila Sanghta and

Dip-Shetu local NGOs. All the NGOs are working with their own target groups and in particular areas (in the CPP area).

All the NGOs work with the rural population except "Uttaran". This NGO is a family Planning and Child Health Care based organization and works only in the Pourashava.

Major activities of the NGOs are awareness building, group formation, credit provision, income generating activities, health education, tree plantation, non- formal education, water sanitation, pisci-culture etc. Water management as major programme, was not found with any NGO.

Out of the three local NGOs, "Dip-Shetu" and "BURO-*Sirajganj*" too, are actively working in the project area and have many people involved in the area. The organizing capability of these two organization could be of great use to CPP in future.

Local Government

The Chairman *Sirajganj* Pourashava, and his office would be ready to assist in future. This newly elected young Chairman was found to be very interested in the CPP activities.

All the Union Chairmen, interviewed, expressed their opinion to be involved with CPP in terms of:

- identification of problems
- advice on planning
- labour supply
- solution of conflicts & disputes
- collection of water taxes and O&M
- co-ordination and motivation of works.

Co-operation and co-ordination

The agriculture sector seems to be much more co-ordinated than the other sectors. This sector is well co-ordinated through the District Technical Committee (DTC). It was stated, however that, except BRDB, other members are not so regular in the meetings.

Co-ordination of departmental activities at district level is done by the Deputy Commissioner through monthly Co-ordination meeting. All the Department heads and NGOs are to participate in this meeting. At thana level, the co-ordination is being loosely maintained. The TNO call meetings for respective departments separately.

Engineering/ Technical departments are also called in a monthly meeting by the DC, where LGED, PWD, District Council, Facilities department, DPHE, R&H & BWDB participate. Departments try to avoid duplication of works. However, BWDB was found to be working independently at the District/Thana level.

The overall co-operation and co-ordination aspects were much more effective during SIRDP (*Sirajganj* Integrated Rural Development Project) period, especially among BRDB, DAE and BADC. SIRDP has been phased out recently and as a result, co-ordination aspects become loose.

Existing groups located in CPP, Sirajganj

A summary position of the existing institutions and societies under Govt. and Non-Govt. Organization in the CPP area is indicated in Table 2.3.

Table 2.3: **Position of existing groups affiliated with different Dept./Agency in Sirajganj**

Name of the Deptt./Agency	No.of Groups		Members		Total	
	Male	Female	Male	Female	Group	Members
BRDB	198	33	6850	1120	231	7970
Fisheries	5		850	-	5	850
Dip-Shetu			3390	3749	125	7139
BURO-*Sirajganj*	233	1028	1165	5140	1261	6305
Uttaran (Mohila Sangstha)			(295)	(27790)		(27790)
a) FPP						
b) EPI			-	-	-	(8218)
c) Medical Treatment			-	-	-	(18797)
CARE	-	30	-	150	30	150
BRAC	-	-	449	1396	60	1845
BRAC	-	171	-	1735	171	1735
BRAC	3	86	162	4385	89	4547
Proshika	325	217	-	-	542	-

The following Co-operative Societies are registered under the Department of Co-operatives, Sirajganj

Name of Society	No. of societies	Members
Land mortgage Bank	1	21
UCMPS Ltd	10	4148
Fishermen Co-operative Society.	5	850
Agric. Coop. Society Ltd.	18	1120
Weavers coop. society	35	4830
Women coop. society	20	417
Other coop. society	15	1190
Total	104	12576

2.6 Socio-economic situation and target groups

The total population of *Sirajganj*, based on extrapolation from the 1981 census is about 292,000 (1991 census data is not yet available). Of the population about 132,000 about (45%) live in *Sirajganj* town.

According to the FAP 12 study of the area behind the BRE immediately north of the *Sirajganj* compartment, and the different surveys conducted by FAP 20 in the project area, insecurity is the main feature of people's life. This affects those living close to the BRE, and those in the North (close to the breaches in *Ratankandi* and *Subhagachha* Unions) most. In those areas insecurity has resulted in a lowering of land prices, a lack of investment and a worsening of the socio-economic conditions.

FAP 20 has identified 5 different interest groups: farmers, fishermen, landless, women and urban dwellers. At present their situation is as follows.

Farmers make up the about 33% of the rural population. Following the building of the BRE, monsoon agriculture became much more secure. Aus and Aman production went up. From 1984 on the breaches of the BRE have made monsoon production unreliable. This insecurity has resulted in two clear shifts in the cropping pattern. High land, particularly areas with sand deposits (due to breaching of the BRE) are now grown to sugarcane. Other land has been brought under irrigation and HYV Boro has now become the main rice crop in the area. High input prices and low returns result in deteriorating of the economic condition of many farmers.

Fishermen are few in number and fisheries inside the CPP area is limited. When the BRE was originally built, it included a number of sluice gates. Though the building of the BRE greatly reduced the floodplain fisheries, these gates allowed at least some fish-fry entry. Due to river erosion a number of gates have been washed away or became non-functional. The retired embankment has no new gates and this has further reduced the fish-fry entry. The socio-economic position of the fishermen community is rather poor.

Landless depend heavily on the agricultural sector for work and for a market for rural products. The insecurity felt by the farm households, and their deteriorating economic condition, is translated into a slack labour, services and goods market. Landless express the need to provide a more secure environment for agriculture and they believe this will benefit them as well.

The position of erosion victims is desperate. Many had small or medium size farms before the river eroded away their livelihood. Some have literally become landless overnight. As there are few alternatives, many have settled on the BRE. According to these "squatters" their social situation has deteriorated dramatically as poverty has aggravated the number and severity of divorce, abandonment, health problems, lack of food and clothing and violence in and among households.

Though from different classes, **women** share many problems when it comes to flooding caused by breaching of the BRE. Due to social and practical problems women are the least mobile during floods. Also women feel responsible for the safety and health of all family members, particularly the young and the old. When homesteads and homes are damaged or even washed away, women become particularly vulnerable. After the floods water sources are often polluted and women feel the results most severely.

Women participation regarding decision making, i.e- marriage, child bearing and other family affairs are dominated by the male members of the family. They also have lack of confidence and courage to voice their opinion, because, they are used to be dominated by the decision of the male members of the family and society.

Due to deteriorating economic situation, paying the dowry becomes a bigger problem. Brides have to give an amount in cash or kind to the bride groom during the marriage ceremony as a condition to get married. Polygamy and illegal divorce are also increasing in the due to poverty. It was found from the household survey that 79% of the surveyed family given dowry during the marriage ceremony.

Only 3 to 4% women are involved in cash earning. Some women are skilled in embroidary, mat making, bamboo stool making and they also have experiences in buying, storing and reselling rice. But they have little scope of employment. Those who produce or make something on their own initiative, find little marketing possibilities.

The **urban population** makes up about 45% of the total population in the *Sirajganj* CPP. *Sirajganj* town has for centuries, and still is, under constant threat from river erosion. Due to local erosion, protection works and the groyne just north of the town at Ranigram, the town has not faced any serious erosion during the last few decades. Nevertheless the population lives under constant fears and private investments in immovable property is low.

2.7 Infrastructure, Hydrology and Water Control Structures

2.7.1 Infrastructure

The *Sirajganj* CPP is bounded on the east by the BRE; the length of which is about 13km from *Sirajganj* town to *Kazipur*. It is an earthen embankment, the crest width of which is about 20' and side slope both C/S and R/S are 1:3. This BRE is provided with five small regulators to allow river water to pass through the embankment for irrigation of monsoon season crops when required. In practice, these regulators seem to be of little use as they did not function properly. Tubewell irrigation are now widely spread over the area. The main purpose of BRE is to prevent river water from spilling over the area during high river stage. But in recent years, due to bank erosion several sections of the BRE needed to be retired and several breaches have also occured causing serious flooding accompanied by sand deposition on neighbouring land.

On the southern side, the area is bounded by the metal road from *Sirajganj* to *Bogra*, the *Sirajganj-Kazipur* road (metal road) bisects the project area. In addition to the above, there are number of both dry season motorable and non-motorable earthen village roads and paths inside the project area. Normal flooding does not interfere with road transport and adequate number of bridges/culverts of different span are provided in it to prevent drainage congestion.

There are a number of khals/rivers within the project area which are used for internal drainage of which are *Baniajan river, Daibhanga khal, Katakhali khal, Ichamati* branch are important. The *Baniajan* river *Daibhanga khal* and *Katakhali khal* originate from the *Jamuna* river presently BRE close the intake of there khals flow in zig-zag way inside the project area and ultimately fall into the *Ichamati* branch originates from the Karatoya river flows in zig-zag way within the project area and ultimately falls into the Ichamati river. In addition to this, there are numbers of minor khals such *Bagdumur khal, Khangati khal, Sundar beel* khal which carry the drainage water of the project into the river. All the above khals/river are now silted up which are needed to be re-excavated for drainage improvement.

2.7.2 Hydrology

The CPP *Sirajganj* area forms part of the Middle Bangali system. The main rivers in the Middle Bangali planning unit are the Bangali, the *Ichamati* and the *Karatoya*. The rivers follow an essentiallly north-south course draining water to the *Hurasagar* and eventually to the *Brahmaputra* (FAP 2, 1992).

In the early 1960's the BRE was constructed to prevent water and sediment spilling out from the *Brahmputra* into the *Bangali* system. This had signficant impact on the rivers in the region; since the construction of the BRE the rivers of the *Bangali* basin have adjusted to these conditions. In the absence of spillage from the *Brahmaputra* through the breaches in the BRE the major sources of sediment is that brought into the system by the *Bangali* and *Karatoya* rivers.

A major recent impact on t e morphology of the rivers in the Middle Bengali basin has been the development of br aches in the BRE during the 1980's. These breaches have had a major impact on the magi itude and distribution of flows in the rivers of the region and had also a major impact on the sediment load of the river.

The hydrology of the area i influenced by a rather flat topography (varying only between 10 m+PWD to 14 m+PW) in the northwest) and the extensive drainage networks (which consists of the river *Ganges* and *Brahmaputra*). The low gradients cause rivers to be meandering heavily and braided and therefore discharge capacities are limited.

These two big rivers, in wh ch the entire area drains, meet at the south east corner of the region. In other words, the drainage of this localized area is totally dependant on the super regional behaviour of the *Brahmaputra* river, of the through flow of which appprox. 90 % is outside B ngladesh.

Specifics

The western boundary of th CPP-compartment is formed by the *Ichamati* river and the eastern boundary is the BRI (See map in back of this volume). The southern boundary follows the *Sirajganj-Bogra* road (New *Bogra* Road). The northern boundary follows the *Ichamati* khal. The major fl oding problems in the CPP-project area is the result of breaches in the BRE which are taking places directly at CPP's boundary or further north. Almost every year, there ar breaches in the BRE (either at CPP *Sirajganj* project area or in upstream areas north of the CPP *Sirajganj* project area) and consequently considerable part of the *Sira iganj* compartment is flooded.

An additional complication s formed by the runoff quantities conveyed by the *Ichamati* river which originates from he upper catchment. Only the *Baniajan* river and *Ichamuti* branch are the only rivers th at flow through the compartment.

At present, the BRE is not s aled. The BRE is eroded near *Shimla* and although difficulties emerged from la d acquisition complications, it has been assured that the construction of two retired embankments concerned will be completed by the end of June 1993.

Needs assessments surveys performed in the CPP *Sirajganj* project-area and its adjacent impact areas indicate that pe ple living near the BRE have severe criticism on:
1) the location of the retired embankments of the BRE: and
2) the quality of the actual mplementation of the retired embankments.

In these surveys, it is also n ted that both quantity and quality of peripheral regulators in the BRE is not sufficient to ulfil the needs of agricultural and fisheries.

2.7.3 The present water control structures

The current status of the water control structures in the CPP *Sirajganj* project area has been assessed by an inventory of all these structures. The actual sizes of the water control structures are measured in the field during the dry season and classified in three groups (See Section 4.8.4 in Annex 4).
1) small (< 10 m^2);
2) medium (10-100 m^2);
3) large (> 100 m^2).

The watercontrol structures are for the smaller structures circular concrete culverts; the medium sized are many times box culverts while the larger size structures are vent sluices. The size of the water conveyance structure refers to the total actual dimensions of the structure which can convey the water.

Many of these water control structures are built by the BWDB, but also by the R&H in case the roads at which these structures are built are classified as feeder roads. It is also possible that these watercontrol structures are built by LGED.

Some control structures are located in the BRE-embankment. The purpose of these inlet structures is to regulate the inflow from the *Jamuna* river into the CPP *Sirajganj* project area. The unpredictable behaviour of the *Jamuna* has caused the usefulness of these structures to be of changing quality. The constantly changing accretion and erosion of land by the *Jamuna* river has made the usefulness of the *Jamuna* water for this particular purpose also variable

The river bank erosion has forced BWDB to adjust existing embankments and in some cases some structures were located behind the latest retired embankment; therefore their usefullness was drastically reduced or even completely nullified.

2.8 Mathematical Modelling

A model is developed to appraise the external as well as internal river system and rainfall-runoff of the *Sirajganj* Compartment. The model is based on the Danish Hydraulic Institute (DHI) software MIKE11 which contains a number of process modules.

The model schematization is developed in such a way that it can test the concept of Compartmentalization and controlled flooding and controlled drainage. The floodplain flow is included in the model. Also the BRE breach situation is included in the model schematization. Presently the schematization cannot be used for internal water management purpose.

The upstream model boundary extended up to Dhunot and the downstream boundary in the *Nalkasengati* in *Ichamati* river. The other internal boundaries are on these channels: *Baniajan, Doibhanga, Ichamati branch, Ichamati khal* and *Bagdumur* and floodplain flow channels. The boundaries of *Ichamati* khal and branch received upstream generated rainfall-runoff.

The model requires a set of data covering topography, boundary data (water level or discharge) and climatological data. A survey is carried out to measure the river cross-sections and existing structures. The BRE breach information is collected from the Surface Water Modelling Center (SWMC, an organization of WARPO). For the calibration purpose, a extensive water level measuring programme is initiated to collect water level at 19 locations both inside and outside the project area. *Sirajganj* rainfall and *Bogra* evaporation data were collected for rainfall runoff model.

The rainfall-runoff model was calibrated against the groundwater level. The *Sirajganj* area is divided into 24 catchment considering the existing infra-structure such as roads and embankments. For parameter estimation, a pilot area is selected (catchment 13) and the NAM model is calibrated in that pilot area. The pilot model is calibrated for the 1986-92. The rest of model is run for 1992 situation. For detailed description of the parameters reference is made to Annex 2.

The hydrodynamic part of the model is also calibrated for 1992 situation. The problem faced during the calibration is that 1992 is a very dry year. The results of the model run for 1992 is compared with the observed water levels in the project area and presented in the Annex 2. For hydrologic and hydraulic design of the structures, channels and embankment, usually the statistical analysis is based on data of number of years. For this purpose the North West Regional Study (FAP 2) recommendation is followed. The *Sirajganj* compartment falls in FAP 2 planning unit number 8. As per the study recommendation for planning unit 8, 1985, 1970, 1973 and 1988 are judged as 1:2, 1:5, 1:10 and 1:20 years return period. So for agriculture and fisheries purposes the 1:5 return period is selected and also the model is used to obtain water level data and discharge data in different sub-compartments.

Inclusion of With Project situation

The basic purpose of the hydrodynamic model is to investigate the hydrological effects of implementation of various engineering interventions such as embankments, drainage channels and hydraulic structure. The calibrated model is used to simulate the behavior of the various engineering interventions. The 'with project' situation is compared with the without project situation. Details are given in Annex 2.

The 'with project' situation includes a number of structures and improved drainage. The operational rule is established for each structure. The capacity and dimensions of the various structures are based on the duration and depth of flooding allowed in the different sub-compartments.

Post Processing of results

The results of the model run have been used to estimate the effect of flooding on agricultural and fisheries output. The period from the 1st May upto the 30 November were divided into decades and maximum 3-day mean water level values for each decade were calculated. The resulting flooding depth per sub-compartment has been subsequently expressed according to the F0 to F4 classification.

2.9 Agriculture and Livestock

In order to assess agricultural situation of the CPP area, *Sirajganj*, a landuse survey was conducted in January - April, 1993. Based on landuse survey results, a base situation, as reported below, is constructed using the land types calculated on assumed water level of 1:5 return period.

2.9.1 Agricultural Land Utilization

From 12057 ha gross area, 9579 ha. is cultivable (NCA) and 3.2% of the NCA remain temporarily fallow (Table 2.4). Land types are distributed as: 2913 ha (30% of the NCA) belongs to F0, 3681 ha (39%) F1, 2715 ha (28%) F2 and 270 ha (3%) F3 categories. Depending on land type, soils and irrigation availability, rice cropping may be single, double or even triple. Triple cropping is practiced in only about 2% of the NCA. Doubly cropped area is predominant and covers 8022ha. A large portion of this double cropped area consists of sugarcane mixed with another rabi crop. Cropping intensity is 184%. Agriculture, based on irrigation developed after the construction of the BRE, is more pronounced in recent years.

Table 2.4: Agricultural land utilization* in the CPP area of Sirajganj, base situation

Sub-Compartment	Gross area (ha)	NCA (ha)	Temporarily fallow (ha)	Single cropped (ha)	Double cropped (ha)	Triple cropped (ha)	Total cropped area (ha)	Cropping intensity %
1	873	750	35	118	566	31	1343	179
2	797	709	12	65	628	4	1333	188
3	1061	893	15	256	616	6	1506	169
4	1371	1132	27	39	1000	66	2237	198
5	2012	656	15	320	1314	7	2969	179
6	1455	1196	19	62	1093	22	2314	193
7	1283	1071	54	13	999	5	2026	189
8	2319	1981	90	98	1747	45	3727	188
9	885	191	36	96	59	0	214	112
Total	**12057**	**9579**	**304**	**1067**	**8022**	**186**	**17669**	**184**
% of NCA			3.2	11.1	83.8	1.9		

* Computation based on Landuse Survey.

2.9.2 Irrigation

There are 913 STWs, 107 DTWs, 23 LLPs and 11 MOTs now in operation in the project area. The number of STWs have increased over the years. No new DTWs have been installed in recent years. More than 20% of installed DTW are out of operation. LLPs are located along the river *Ichamati* and *Doibhanga* and around perenneal beels. Around 32 ha. of land around water source is irrigated by traditional method. 50% NCA (4759 ha) is irrigated.

A detailed information and analysis of groundwater resources has been presented in Annex 6, Section 4.1.5. In general, water levels are in the reach of suction lift pumps. Groundwater availability is at present sufficient, however, water tables show a decline in some wells.

2.9.3 Cropping Patterns

Rice, being the major crop, dominates the cropping patterns of the project area specially with the rapid expansion of irrigation. At least 27 different cropping patterns are practiced. Most of these patterns composed of two crops with at least one rice crop. Of these, 10 major patterns cover more than 90% of the NCA. Boro (HYV)-T.Aman (local or HYV) pattern occupies 39% of the NCA. Similarly patterns involving sugarcane cover 39% of the NCA. Sugarcane is grown inter-cropped with at least another crop. These are pulses, potato, mustard, spices, winter vegetables and others. This practice provide farmers with opportunities of harvesting different crops from the same land increasing total land productivity.

Cropping patterns are directly related with land types F_0 and F_1 land types show wide variability. When 16 different cropping patterns are observed on F_1 land type, only 2 cropping patterns can be seen on F_3 land type. Although T.Aman HYVs are grown normally on F_0 land, in the *Sirajganj* areas, they are usually grown on F_1 land types with expectation of damage in case of water level exceeding 1:5 year return period (Table 2.5). However, T. Aman HYVs are grown on higher elevations of F_1 land type.

2.9.4 Crops

Rice is the most important crop and is grown throughout the year. Main among these, HYV Boro is predominant utilizing the extensive expansion of irrigation facilities, (Table 2.6). Both local and HYV of T. Aman are grown. Deep water or broadcast Aman varieties are not grown in the project area. Sugarcane is extensively grown, usually intercropped with at least another rabi season crops, although there is no commercial sugar mill around. Among other non-rice crops, jute, wheat, pulses, mustard, potato, vegetables are important.

2.9.5 Crop Yield and Production

The main agricultural activity of the *Sirajganj* CPP is in the safe crop environment of rabi season. Rice production mainly depends on irrigation and on HYV Boro. Expansion in irrigated Boro area has its potential and limitations. Being located in the drier region of Bangladesh and under constant threat of embankment breach, input use is not high.

It would appear that a total of some 25800 tons of cereal including some 23400 tons of paddy are produced in the project area. 81% of the total paddy production is at present derived from irrigated HYV Boro. A production loss of 4130 tons of paddy is estimated mainly by flood.

Table 2.5: Cropping pattern by land type in the CPP area in Sirajganj, base situation

Pattern	Land Types				Total	% of NCA
	F_0	F_1	F_2	F_3		
Single						
Sugarcane	740	-	-	-	740	7.7
Boro (HYV)	-	-	-	258	258	2.7
T. Aman (HYV)	25	-	-	-	25	0.3
Others	32	12	-	-	44	0.5
Double						
S.Cane + Pulses	286	220	516	-	1022	10.7
S.Cane + Potato	211	419	149	-	779	8.1
S.Cane + Mustard	320	105	321	-	746	7.8
S.Cane + Spices	303	-	-	-	303	3.2
S.Cane + Winter Vegetables	38	-	-	-	38	0.4
S.Cane + Others	83	-	-	-	83	0.9
Boro (HYV) - T.Aman (local)	-	1427	1323	12	2762	28.8
Boro (HYV) - T.Aman (HYV)	236	804	-	-	1040	10.9
Boro (HYV) - Mustard	-	100	253	-	353	3.7
Boro (HYV) - Other Vegetables	-	13	-	-	13	0.1
Wheat - Jute	519	336	-	-	855	8.9
B.Aus - Others	10	-	-	-	10	0.1
T. Aman (HYV) - Jute	17	-	-	-	17	0.2
T. Aman (HYV) - Winter Vegetables	1	-	-	-	1	-
Triple						
Boro(HYV)-T.Aman(HYV)-Mustard	-	75	-	-	75	0.8
Wheat-Jute-T.Aman (Local)	-	-	26	-	26	0.3
Wheat-Jute-T.Aman(HYV)	-	63	-	-	63	0.7
Jute-T.Aman(HYV)-Pulses	-	5	-	-	5	0.1
Jute-T.Aman(HYV)-Others	-	1	-	-	1	-
B.Aus-T.Aman(HYV)-Wheat	-	9	-	-	9	0.1
B.Aus-T.Aman(Local)-Wheat	-	3	-	-	3	-
B.Aus-T.Aman(Local)-Mustard	-	4	-	-	4	-
Temporarily Fallow	92	85	127	-	304	3.2
NCA	2913	3681	2715	270	9579	100.0

Source: Based on Landuse Survey, CPP, 1993

Table 2.6: Crop area, pr oduction and production loss due to flood in the CPP area, *Sirajgan*

Crop	Da mage free		Damaged		Production (tons)	Production loss (t)
	Are a (ha)	Yield (t/ha)	Area (ha)	Yield (t/ha)		
B. Aus	19	1.28	7	0.79	30	3
T.Aman (Local)	143	1.35	1361	0.40	2480	1293
T.Aman (HYV)	279	3.17	957	1.00	1841	2077
Boro (HYV)	265	4.41	1846	4.00	19093	757
Total paddy					23444	4130
Wheat	93(	2.44	26	2.00	2321	11
Sugarcane	272	50.20	986	47.54	183666	2623
Jute	941	1.43	26	0.98	1371	12
Pulses	102	1.03	-	-	1058	-
Mustard	117	0.79	-	-	931	-
Potato	785	9.79	-	-	7685	-
Spices	30	1.31	-	-	397	-
Winter Vegetables	46	4.76	-	-	219	-
Others	138	-	-	-	-	-

Source: Based on Landuse Survey, CPP, 1993

2.9.6 Livestock

Livestock in the CPP *Sirajgan i* area virtually kept on small farms, as an integral part of the farming system. Cattle, g ats and chicken are the most important animals of the rural households in the project area Bullocks are kept mainly for draft purposes and for transportation, cows for milk. Goats, sheep, chickens and ducks are kept for cash income and as a source of protein. C wdung is used as fuel in rural areas, due to shortage of firewood.

Traditional cultivation, as is p acticed now, depends on draft animal. It is estimated that there are around 6000 draft ar imals in the CPP area. There is a shortage of draft power and this shortage is usually m de up by using cows, hire-in arrangements and through exchange among households, ither on daily basis or under contract. The use of power tiller as substitute for draft an nals is very limited. The number of draft animal is declining because of high mor ality rate, shortage of cash in hand, lack of medicare facilities and high price of cat e heads. In need, drought animal reaches the market from neighbouring districts or elsew here.

Cattle are fed mainly on crop esidues and by products. Paddy straw is the main feed though cattle are grazed on ter porarily fallow land after harvesting of paddy crops as

well as on road sides, canal embankments and other unused grounds. Char lands along the *Jamuna* produce cattle feed in excess. However, fodder shortage is acute after a flood season. Import of straw occurred in some years.

The poultry numbers are increasing. This is because of higher price support and NGO activities with women s participation. High mortality rate among poultry birds is due both to lack of vaccinations and also to impure or out of date vaccinations.

Different types of epidemics generally break out during and after floods if adequate preventative measures are not taken. Occurrance of liverfluke infestation is most severe in *Sirajganj* compared with the rest of Bangladesh. A field disease investigation laboratory serving the region is located in *Sirajganj*. The average health condition of the animals in the area is not good.

2.9.7 Forestry

Natural forests are non-existent in the CPP area. There is an active programme on social forestry or roadside for tree plantation programme executed by Thana Forest Development Programme or even NGOs, like Proshika. Proshika maintains 13 km. of road side tree plantations within the CPP area. A total of 90000 trees were planted.

2.10 Fisheries

The Department of Fisheries (DOF), has been monitoring fisheries and aquaculture through Bangladesh Fisheries Resources Survey System (BFRSS). This monitoring system indicated that from a base of 488,000 ton/yr, there is a decline of 44,000 ton/yr in fish production obtained from different water bodies (floodplain, beel and river) during the period 1983-1989. But the aquaculture output of Bangladesh increased with 48,000 t/yr within the same period which covers up the losses of the inland fisheries.

The total fish production of Sirajganj district decreased drastically from 31,000 t/yr in 1983 to 14,000 t/yr in 1989. This decrease in fish production mainly took place in the floodplain and beels.

The main reasons for this decline of the inland capture fisheries output are:
- Blockage of migratory routes of carp spp.
- Reduction of fish habitat due to BRE
- Destruction of fish breeding and nursing ground.
- Capturing of undersized fish and brood fish.
- Fish disease (Epizootic Ulcerative Syndrome).
- Overfishing.
- The intensive use of agro-chemicals.

Within the CPP area the decreasing fisheries production trend was reported by professional fishermen during Need Assessment Survey.

The total fisheries output of he CPP area for the season 1992/1993 is estimated at 383 t/yr and is calculated with da a obtained through the Household Survey and the special fisheries Study of the CPP p oject

HABITAT	PRODUCTION (T/YEAR)			TOTAL
	PROF	OCCAS	SUBSIS	
RIVER	244	2	5	251
FLOODPLAIN & KHAL	27	3	1	31
BEEL	11	1	0	12
PITS	18	1	0	19
AQUACULTURE				70
TOTAL	300	7	6	383

Source: Fisheries Household Survey and CPP Special Fishery Study

Fishing activities in the proje t area can be divided into:

i) Professional fisherı ıen: There are approximately 800 households of professional fisherr en and their main occupation is fishing throughout the year.
ii) Part-time or occasi nal fishermen: There are approximately 50 households of occasional fisherme n. Beside fishing, they have an alternative occupation.
iii) Subsistence fisherm en: Approximately 3-10% of 29,300 households, or 2000 household, are eng: ged in subsistence fishing, which is substantial less as the average of 73 % es imated by DOF for the whole of Bangladesh They catch fish mostly for thei own consumption.

Fishermen Cooperative:

There are 5 registered fishern en cooperatives in Sirajganj Sadar Thana. They are:

i) Sirajganj Municipal Matshajibi Samity. Member: 150.
ii) Sirajganj Thana Un ayan Matshajibi Samity. Member: 118.
iii) Kalia-Haripur Matsl ajibi Samity. Member: 301.
iv) Garadaha-Dhibal Sa nabaya Samity. Member: 108.
v) Bhumiheen/Bit:ahee Pukur Samabaya Samity. Member: 108.

A survey executed by FAP 2C indicated the existence of 330 ponds covering a total area of 100 ha. The main species c ltured are major carps, common carp, tilapia, silver carp, grass carp. Fry is mainly obta ned from natural sources as well as from Nimgachi hatchery. The annual aquacult re production is estimated at 70 ton with an average pond size 0.30 ha and a production evel of 700 kg/ha/yr.

2.11 Urban area: Sirajganj town

Sirajganj Town, is located in the south-east corner of the *Sirajganj* CPP and on the Western bank of the *Jamuna* river. Most of the land is high or medium high with some lower spots.

The population of the town is about 132,000 of which 70,000 are male and 62,000 are female. Most of the population is mainly engaged in non-agricultural earning activities like services, handicraft and business.

Main problems are relating to the erosion of the *Jamuna* river, insufficiency of the surface drainage and sanitation system, solid waste disposal system especially in the central part of the town and the occasional river flooding.

Hydrological Situation

Sirajganj town is mainly affected by the erosion of the West bank of the *Jamuna* river. Previously *Sirajganj* town would mainly be affected by severe erosion of the west bank of the *Jamuna* river but after construction of the groynes and other protective works the erosion has stopped now. Low lying pockets and ponds of the town are generally filled up by the early rainfall of April-May. The *Baral* river (*Dhanbandi*, *Katakhali* canal) originates from the *Jamuna* river flowing through this town in west direction and ultimately meets with *Hurasagar*, but is now almost silted up due to the construction of embankment of its mouth. *Katakhali* khal also is flowing through the *Sirajganj* town and meets with the *Baral* river in the town. It is also silted up now due to the disposal of garbage and growth of water hyacinth. The main problem of the town is rain water logging during monsoon due to inadequate drainage channel and flood water congestion due to back-flow from *Ichamati* river via *Rahmatganj* khal.

North-West part of the town which include *Ranigram*, *Kushahata*, *Khurka*, *Chakpara*, *Beparipara*, *Bahirgo* remain under water of about 0.3m to 0.6m depth for about 2 to 3 months during monsoon.

1988 Flood

During the 1988 flood the town area was inundated by water of depth varying from 1.5m to 2m and it took about 8 to 10 days to drain the water out. Flood water entered the town area by breaching BRE. There was also a back-water affect of the *Ichamati* river. Considerable loss of property occured due to the 1988 flood. Stored foodgrain, agricultural products and business products were lost and many domestic animals lost their life.

Ground water

People use water supplied by *Sirajganj* Municipality. Most of the people use public tubewells water which are supplied by Municipality. Some people have their own private tubewell and some people also use open well water for washing clothes, household utensils and bathing etc. It is possible that an excessive demand of shallow tube wells in

the area (especially during the dry season) may affect the ground water recharge and thus the ground water level (FAP 12, 1991).

Homestead Gardening

Homestead forest is well developed in most of the town area. The homestead forest comprises with varieties of trees such as herbs, shrubs, mango, jackfruit, lemon, banana, hardfruit tree, shimul, kadam, shishu etc.

Fuel

The main source of fuel is saw mill powder. Electricity exists in all the parts of the urban area but the use of electric heater is very limited due to its high cost. The more affluent people use firewood, cow-dung and some use L.P gas. The poor use mostly dried leaves, bushes and remains of paddy and wheat as their fuel source.

Drinking water

There are large numbers of (shallow) tubewells in the area. About 90% of the people use tubewell water for drinking purpose. Only a few people use open well water. Open well water and tubewell water are also used for washing, cleaning and cooking purpose. Rich family use piped water supply for household consumption and drinking purposes.

Sanitation

The sanitary condition is very poor. Most of the people use katcha latrines, the bad smell of which pollutes the air. Middle class families living in pucca building have septic tanks. The sewage/storm water system is inadequate for this urban area.

Diseases

Diseases like diarrhoea, dysentry, smallpox, and scabies are common in the area. Most diseases occur in the month of October, November, February, March and April, while scabies prevails in the month of January, February and March.

2.12 Environmental Situation

Environmental Hazards and Risks

Major environmental concerns are associated with an increasing shortage and overexploitation of the natural resource base such as good quality water, agricultural land, homestead plantations, grazing areas and other common goods for fodder, fuel, timber, medicinal plants and floodland fisheries habitats, etc. The high population density of about 2400 people per km2 (including *Sirajganj* town) resulted in the transformation of a highly diversified floodplain ecosystem into a paddy landscape which is becoming increasingly susceptible to further biological imbalances.

Environmental insecurity is related to natural hazards and risks arising from previous human interferences in the floodplain ecosytem. Natural hazards in the CPP area are related to agro-ecological, hydrological and physiographic features. They make the area vulnerable to seasonal, unpredictable river floods from the *Jamuna* and *Ichamati* Rivers, river bank erosion and land losses to rivers, siltation of beels and sedimentation of khals, waterlogging after heavy thunderstorms, droughts and pests. Breaches of river embankments exacerbate such hazards. Technical risks are associated with the indiscriminate use of agro-chemicals and chemical pollution from cottage industry and urban industry. These show an increasing trend in pollution and local data is urgently required to develop an environmental management plan.

A survey on people's views regarding their water-related problems showed that monsoon floods, drainage congestion in khals, stagnant pools and ditches have been perceived as the common problems. Disastrous BRE-breaches are the major risk at present. They have potential to hit almost all CPP areas, damaging homesteads, settlements, infrastructure, livestock and crops

Sensitive environmental resources and their current impairments in the *Sirajganj* areas are:

- permanent swamps (beels) are almost extinct and seasonal floodplain habitats are diminished;
- terrestrial and aquatic biological resources are becoming unbalanced and thus, susceptibility to pests and diseases increases;
- surface and groundwaters, which are polluted by organic wastes;
- decrease in water table (at some sites) and thus a reduction in water availability to rural villagers;
- public health hazards have potential for epidemics, especially water-related communicable diseases;
- shortage of biomass energy availability;
- shortage in fodder for livestock;
- soil fertility decline due to reduction in siltation and changes in soil moisture status.

Biological Trends

The CPP *Sirajganj* is located in the Middle Bangali floodplains along the *Jamuna* River. This area shows a continued elimation of natural floodplain habitats that were once common, but that now are highly specialized for crop production and at risk of biological imbalances. Previous works and roads with far too small and few culverts cumulatively contributed to the change in flood pattern and regime and, thus, to the continued loss of important habitats that support wetland species diversity. Perennial beels have basically disappeared and only 55 ha (0.46% of the total area) are left. These beels and few homestead plantation thickets are, nevertheless, a few remaining vital sites of faunal and floral diversity.

Water Resources Use

There is an increasing shortage of good quality surface waters for urban and rural areas. The extinction of many waterbodies contributed to shortages in rural areas, whereas the

organic pollution of pond and khal waters is severe in the town of *Sirajganj*. Water supply through dugwells is insufficient, especially in rural areas. Groundwater availability is at present sufficient, however, water tables show a decline in some wells. This is probably the result of increased abstractions for irrigation and reduced recharge from monsoon flooding.

Land use and resources competition

Land is a scarce resource in the context of the Bangladesh environment. The rapid population increase over the past century resulted in a population density well above 1700 people per km2 in rural areas. Consequently, the entire land is intensively used for agriculture, rural settlements infrastrucuture and urban developments. Competition occurs between various rural land uses and between urban and rural land uses. Most important trends are the continued loss of agricultural and homestead plantation land to urban and rural settlement developments, loss of seasonal and permanent beels to croplands.

Public Health

Public health and nutrition are in a poor state but prevalence of major epidemics is low in the *Sirajganj* CPP. Most acute are problems of safe drinking water, sanitation and the lack of safe waste disposal. The most important health problems, however, are generated mainly due to the poor socio-economic status of the population.

Common diseases have a high rate of occurence and have a definite pattern associated with the flood and rainy season period. The known vector hazards include endemic diseases such as malaria, Kala-azar and filariasis. Most important, however, are water-related diseases such as diarrhoea, bacillary dysentery, cholera, hepatitis and typhoid and parasitic diseases. All are related to polluted sources of drinking water and to oral-faecal contact. The water-washed diseases include skin and eye infections such as scabies, yaws, leprosy, typhus, trachoma and conjunctivitis. The most important parasitic diseases are helminthic infections.

Although secondary source data indicate that most of these diseases will be less directly influenced by flood control and drainage works, they are still integrally linked to the hydrological and drainage changes. There is an increased risk in some vector-borne and water-washed diseases, if control measures are not being integrated into an water management plan.

3 DEVELOPMENT TARGETS

3.1 General

According to the FAP 20 ToR the overall objective of compartmentalization is:

> *"...to provide, through water management, a more secure environment for intensive agriculture, fisheries and integrated rural/urban development, and thereby improve the economic security and quality of life of the floodplain population" [ToR, p.3].*

The objective can be reached through a combination of structural and non-structural targets. The structural elements enable water management under real field conditions while the non-structural elements are to ensure the use of the structural elements in such a way that maximum social benefit can be derived. In the next two sections both elements are covered in more detail.

3.2 Structural Targets

3.2.1 General

The specific physical objectives are the establishment of a compartmental water management system which is feasible, achievable and sustainable providing for:

- controlled flooding into and within compartments.
- controlled drainage within compartments and between neighbouring compartments.
- improving agriculture and irrigation.
- improving fisheries and aquaculture.
- improving communications.

Structural targets should aim at solving, the water related problems of the area, as expressed during the Needs Assessment Survey and establishment of the detailed water management system

- Flood through bank erosion of the *Jamuna* as well as breaching of the BRE. These cause water congestion and sand deposits through *Jamuna* spill.

- Partial or total silting up of beds of internal khals, *Ichamati* khal, *Ichamati* river resulting in impaired drainage.

- Substantial crop damage specifically during monsoon season due to flood through embankment breaching and back flow of water through *Ichamati* river.

- Due to partial or total siltation of all the internal channels, river beds and perenneal water bodies and mal-functioning of sluices on the BRE, the migration routes of the hatchlings became closed.

Structural targets, in general, should address the above problems in development of compartment and sub-compartments. In doing so, structural targets concerns the following areas:

- Flood protection at the compartment level.
- Breach management.
- Water management for agriculture.
- Water management for fisheries.
- Water management for urban areas.
- Water management for adjacent areas.

The possible technical solutions that are envisaged in order to reach these targets should take into account the hydrological cycle, deviations from the expected hydrological situation and land types.

3.2.2 Flood Protection at Compartment boundary

The flood protection measures are to be taken regarding floods which originate from waterlevel raising from the secondary river system (thus excluding the *Jamuna* river) beyond a certain probability level.

Flooding can be caused by:

1) a local BRE breach on the boundaries of the *Sirajganj* compartment;
2) major runoff as a result of local rainfall upstream of the CPP *Sirajganj*;
3) backwater (or back flow) effect from the *Karatoya* river back into the *Ichamati* and *Baniajan* river
4) any combination of the above three.

For prevention of flood damage, a flood proof peripheral embankment and in-and outlet structures are pre-requisites. The BRE, assumed to be stable, provides flood protection from the *Jamuna* river, while an embankment for floods originating from secondary river system, *Ichamati*, is proposed.

3.2.3 Breach management

Breach management measures are those which can cope with the impact of breaches occurring as a result from the erosive force of the *Jamuna* river. The *Jamuna* erosion affects the eastern boundary of CPP.

In physical terms this means that the actual impact of a breach occurrence is managed through the construction and upgrading of roads which serve as embankments. Also water control structures which are to be constructed for control of excess floodwater through the BRE breach are being proposed.

Furthermore, these roads/embankments confine the floodwater to a certain area, (one or more sub-compartments) depending on severity and duration of the breach. Subsequently the excess floodwater will be conveyed through water conveyance structures to the

drainage system. These crucial roads cum embankments should be sufficiently stable and designed according to special design criteria.

3.2.4 Water Management for Agriculture

One of the targets of the structural interventions is the water management for agriculture. Flood protection and breach management measures as described above will lead to prevention of crop damage. This security of the crop environment can be utilized to develop an effective water management system utilizing the compartment and sub-compartments.

The aim is to develop field block (or chawk) level water management. Individual sub-compartments are composed of several field blocks or chawks bounded by village roads or settlement areas. These chawks are physical entities and easily recognised by village people. Each field block has water inlets or outlets through bridges, culverts, roads breaches etc. By sealing road breaches, placing minor structures, pipe culverts, water retention devices, an effective water management at the field level will be established. Three of the important components of water management for agriculture are:

- **Drainage Improvement**: The actual impedance of drainage water in pre-monsoon and post-monsoon within the context of the existing infrastructure is a main constraint in further developing the area with an improved water resources control which should lead to increased agricultural production. Re-excavation of existing khals is proposed.

- **Water Retention** Water retention to the physical withholding of water on the field or in a depression (or beel) in order to evenly distribute water specially rain water on different levels of land contours. This can be realized either by the construction of bunds or by the construction of water retention structures located in a depression, khal or existing beel.

- **Irrigation**: Supplemental irrigation is an important component in water management. In *Sirajganj* area, us of STW for supplemental irrigation is common using the underground water. Use of surface water irrigation is very limited in areas near mainly to *Ichamati* khal. With re-excavation of khals and water retention measures, water can be stored and managed for supplemental irrigation. Possibilities of irrigation inlet construction is phased later when surface water is available through the construction works of initial phases.

Four distinct agro-hydrological periods; pre-monsoon, monsoon, post-monsoon and the dry season with different management needs are considered.

Pre-monsoon (March to June)

During this period the Boro is harvested. It is cultivated from lowland upto high land areas. This crop may be damaged by water logging caused by execessive early rainfall or an early high stage of the river.

Damage can be reduced by providing an effective drainage system. Furthermore, water retention can be established by construction of bunds on higher lands. An early high stage of the river can possibly be semi-controlled by installing and operating the peripheral/ internal structures.

Monsoon (July to September)

One of the aims of the project is to increase the area planted to monsoon rice including T.Aman (HYV). Due to the risk of high waterlevels from mid-July onwards, the present situation restricts the cultivation of extensive HYV Aman. In order to improve this situation, the waterlevels within the compartment should be lowered. The highest water level occuring during July-August will determine the potential area planted to T. Aman.

In order to get lower waterlevels during monsoon within the compartment, the following elements are considered:

- peripheral control
- control intake of water in the compartment through the *Ichamati* branch
- control between the *Ichamati* river and the sub-compartments (controlled flooding and drainage)
- control between the sub-compartments (controlled flooding and drainage)
- water retention on the higher grounds especially highland and medium high land.

"Control" may assume various levels, including "semi-control" by ungated structures.

Post-monsoon (October)

During this period the lower land should be drained as early as possible in order to permit the cultivation of oil-seeds or other rabi from November onwards. The required water management element is the drainage of the low lying areas (not the permanent beels). This can be established by improving the existing drainage system.

Dry-season (November to February)

The dominant activity during this period is the irrigation of the Boro crop by means of shallow and deep tube wells. Early drainage will enable timely sowing of Boro and a slight increase in the potential area.

3.2.5 Water management for fisheries

Improved water management for agriculture will always have an adverse impact on fisheries due to the fact that the "water needs" of both production systems are in principle conflicting. Structural design and operation rules of CPP accommodate the water needs for both systems.

On the basis of their b haviour, mainly related to migration and reproduction, the fish species of Bangladesh an be divided in two groups. These two groups of fish species have different water ne eds and hence different targets in relation to water management.

(a) The so-calle **"white fish"** migrate upstream and laterally to the inundated oxbow lakes and embankments adjacent to the river channel in the late dry season or early rainy season in order to spawn in the quiet sheltered and nutrient rich waters. The eggs and new born larvae of these species are transported passively by the flood into the floodplain area, where they feed on the developed plankton. At the end of the rainy season, the adults and young of the year esca e to the main channel in order to avoid the harsh conditions of the floodplain du ring the dry season. "White" fish belong mainly to: Cyprinidae and Pangasidae, (Mrigal,Rui,Katla, Pangash, etc). Further in this report this group will b referred as **"river fish"**.

(b) The so-calle **"black fish"** are mainly omnivorous/carnivorous bottom dwellers, They reprod ce at the onset of the pre-monsoon as the water level in the "beels" start rising due to the congestion of rain water. They general have complex bre ding pattern with multiple spawning, a great degree of parental care and the migrate only laterally. At the end of the rainy season the young of the year a id adults migrate back to, or get trapped in the low lying "beels" where they c n survive the harsh conditions of these permanent water bodies during the d y season. They are adapted to resist low dissolved oxygen concentratio and high water temperatures. The main adaptation is their auxiliary respiratory organ used for the uptake of atmospheric oxygen. The main species of the "black" fish are belonging to the Clariidea (Magur), Ophiocephalidea (Taki, Shol) and Anabantidae (Koi,Kholisha). Further in this report this gr oup will be referred to as **"beel fish"**.

Optimal water manage nent for agriculture as flood protection and drainage affects both types differently;

* Flood protec ion especially influences the river fish negatively as spawning grounds, nur ing area for the hatchlings and on-growing fish is reduced.
* Drainage of he rainwater congestion during the pre-monsoon hampers the reproduction of "Beel" fish due to an decreased rise in waterlevel in the beels, needed to sti nulate spawning and limits recruitment even further due to a reduction in nursing area, needed for the just born larvae.

In order to increase the fisheries production within the project area, the following elements are considered :

* Controlled w ter intake from the *Jamuna* river through "fish friendly" regulators (lo w sill level,free flow, not submerged outside, not submerged inside, low/m edium water velocities). Operation rules will be defined in order not to interfe e with the inward migrating hatchlings of "river" fish.
* Structural int rventions for improvement of drainage will be executed in such a way that natu al spawning of "beel" fish will be guaranteed as much as

possible. A certain amount of rainwater congestion will be permitted in the beel area's during the pre monsoon. This can be done by the installation of fixed sill levels at the entrance of the drainage canal, below this level drainage will be impossible or by the construction of submergible embankments.

Flood protection will have a positive effect on aquaculture as ponds get not flooded anymore and the potential area where this kind of activity can be executed will be expanded.

3.2.6 Water management for urban areas

In the existing situation, *Sirajganj* town areas may get flooded occasionally from high river stages, intensive rainfall or a combination of the two. The water management elements as required for the safety of the compartment and for agriculture will improve this situation, especially with respect to the river flooding.

Flushing of sewage system and industrial waste is of concern for *Sirajganj* town water management. The *Baral* river is to be re-excavated from its intake at BRE upto the *Hurasagar* river with provision of one flushing sluice as its intake for flushing purposes. A number of existing culverts shall be modified to increase their flowing capacity. A few new culverts are needed to be constructed. The existing internal drainage system within town are also needed to be improved to remove waterlogging. Existing drains are inadequate in size, length and number.

3.3 Non-structural Targets

3.3.1 Socio-economic

The overall aim of compartmentalization is to improve the economic security and quality of life of the floodplain people. According to the ToR, FAP 20 aims, more specifically, at the following socio-economic targets;

- involvement of beneficiaries and those negatively affected in planning, design, construction and operation,
- creating of employment opportunities for disadvantaged groups during construction as well as in on-going operation and maintenance work,
- protection and compensation of groups that are adversely affected,
- special emphasis in all activities on minorities and women.

The above mentioned targets are worked out in different ways throughout the project life cycle. Beneficiaries, as well as those negatively affected by compartmentalization, are involved in all stages of the project. Through the needs assessment the different interest groups are given the opportunity to indicate their needs. These are then taken into account in planning and design, in as much as the aim of testing the compartmentalization concept allows.

In a series of consultation meetings the interest groups are given the opportunity to comment on possible technical interventions. On the basis of their response, plans are adjusted and/or fine tuned.

During construction 30-50% of all earth moving work has been reserved for Landless Contracting Societies. If there are enough LCS they will be awarded 100% of the earth moving work. Half of that minimum quota is reserved for women. Those potentially negatively affected by the project, mainly those living to the North and North-West of the *Sirajganj* CPP area, are the first to qualify for such employment opportunities.

It is proposed to compensate those likely to be negatively affected through land acquisition and crop loss by implementing the recommendation of FAP 15. It should however be pointed out that at the time of writing this report these recommendations have not yet been approved and made into law. Until such time the existing, less favourable rules and regulations will have to be followed.

All turfing and regular earth work maintenance has been reserved for destitute women. If insufficient women groups are available male LCS might temporarily be given such work.

In all institutional arrangements proposed by the project, special emphasis is given to genuine representation of the weaker sections of society, including women.

3.3.2 Environmental

Environmentally sound management in the context of compartmentalization should be aimed at maintaining the long-term natural resource base of the floodplains which are one of the most productive ecosytems in the world. In detail, environmental management should aim at:

- minimum interference into natural flood pattern and regime to preserve wetland values such as biodiversity to the benefit of future generations; periodic flooding should be seen as a benefit and there is considerable scope to built on the ability of floodplain farmers to cope and recover from normal annual floods
- reducing risks which arise from natural hazards such as desastrous high river floods, bank erosion and prolonged flooding of croplands
- developing of multiple-user oriented guidelines of controlled flooding (regarding extent, duration and timing) to the benefit of agriculture fisheries and considering long-term environmental aspects such as
  - * maintaining soil fertility in intensified agricultural systems
  - * replenishment soil moisture during seasonal floods
  - * preserving groundwater availability for domestic water supply and irrigation developmens
  - * maintaning the wetland biodiversity by re-establishing the seasonal flood pattern and regime which is disrupted by the construction of the BRE
  - * health control: (1) environmental management for disease vector habitat control such as flushing of stagnant waterbodies or overland flow and (2) environmental management to control water-related diseases caused by organic pollution

  * preserving biological balances in a floodplain ecosystems by providing a large variety of seasonal aquatic and wetland habitats
  * conservation of key beel areas for endangered and threatened wetland fauna and flora
- removal of human-made blockages which cut across natural lines of inundation and drainage and which cause impeded land drainage, eg. road embankments and sedimentation in rivers and khals
- reducing technical and managerial risks caused by the manipulation of seasonal floods (see Annex 6. Section 5.3) there is, based on experience with existing FCD/I developments, some doubt that complex management can be considered practical
- reducing potential risks which are associated with the distribution of industrial/cottage industry toxins during the flood season
- enhancing the development of underutilized terrestrial bioresources which will benefit from controlled flooding, such as homestead, embankment and crop field border plantations for multrpurpose uses, eg. for fodder and fuel
- mitigating impairments of soil, water and biological resources which are caused directly or indirectly by flood and drainage works; such impairments should be identified by a monitoring programme.

A number of detailed criteria for environmentally sound development of flood and drainage control measures are given in Annex 6 which refer to

- planning and design
- construction phases
- operation and maintenance.

Specific environmental targets will be outlined at a later planning stage and after completion of the special surveys. Tentatively, the following mitigating and enhancement measures are proposed:

- wetland conservation programme in key areas
- homestead plantation programme
- embankment and roadside plantation programme
- integrated pest management programme at selected key areas
- water-related disease prevention programme (urban areas)
- environmental awareness and education programme.

3.3.3 Institutional targets

Organisations are required to use, operate and maintain the compartmental and sub-compartment water management systems. The organizations need to ensure that (possibly conflicting) interests can be clarified and that fair and sustainable compromises are reached and put into practice. In this process, the various functional and socio-economic interests of the concerned people of the are a need to be reflected and solutions need to be supported by these people.

This requires decentralization of decision making to the smallest possible level. In this context, this is the sub-compartment, which acts as the smallest unit where integrated water management will be possible. Currently, there are no institutional mechanisms at

any level. The interventions of various technical governmental and non-governmental agencies in water related issues are not linked to each other and lack a more comprehensive long-term vision. Also experience with mechanisms for representation of various interest groups for water management needs to be built up. CPP's institutionalization programme intends to address these coordination and representation issues. Specific attention is paid to identify the various interests of women in water management and their capacity to contribute as well as represent these interest in WUG and SCWMCs.

The institutional arrangements that CPP proposes to establish in *Sirajganj* compartment addresses the cooperation between line departments and non-governmental agencies, involvement of local government and cost-recovery issues.

Stimulate direct involvement of and close collaboration among the various line departments and non-governmental agencies active in this field.

Integrated water management is, so far, not delegated to any existing department or agency. Various technical departments undertake activities that relate to the concerned issues and factors. Their interventions are conceived and undertaken in relative isolation. A multi-disciplinary approach to water management needs to accomodate the various perspectives and should draw on the expertise and resources of the various governmental and non-governmental agencies (NGOs) involved.

In practical terms, CPP will initially relate to District level and Thana level GOB agencies and NGO's. Gradually the more specific mechanisms for interaction at the compartmental and sub-compartmental levels will be developed. These are departments such as the Department of Agricultural Extension, Local Government Engineering Department (LEGD), Bangladesh Rural Development Board (BRDB) and Bangladesh Water Development Board and other GOB agencies, such as Fisheries, Forestry, Livestock, Roads & Highways and Bangladesh Agricultural Development Corporation (BADC).

Active Non Government Organisations (NGO's) will be encouraged to join such arrangements for coordination and collaboration on building peoples organizational capacity in water management. Their existing services in terms of organization and management training include approximately 760 landless and 1570 women groups in *Sirajganj*.

Facilitate the involvement of local government.

Compartmentalization through integrated water management in a protected area is more than a technical intervention. It relates to the comprehensive development of an area. This makes it mandatory to work closely with the various local government structures and to find ways for merging (sub-)compartmental water management arrangements with present and future administrative and political structures. These structures exist at District, Thana and Union level. All three levels will find a place in the institutional set-up proposed and to be tested by the CPP in *Sirajganj*.

Within the time available, this project will fine-tune the formal and operational mechanisms for these links to the public administration and political system. Ultimately CPP will prepare detailed recommendations on this matter.

Test strategies for long-term incorporation and cost-recovery of compartmental water management arrangements.

CPP is a very conscious of the need to find a sustainable foundation for the institutional arrangements developed, outside a project context. There are two aspects to this issue:

- the need to incorporate legal, administrative and fiscal responsibilities for water management into a well-established governmental organisation, and,
- the need to create a long-term financial basis for future operation.

While this project can and will undertake many initiatives out of its temporary mandate and budget, in the long run the institutional arrangements for (sub-) compartmental should become the legally defined and administratively secured responsibility of an existing GOB institution. At this time it is not clear which agency - and at what level- this should be. CPP will explore the issue and prepare recommendations that reflect the experiences in *Sirajganj* as well as Tangail. The same applies to the other issue: while the initial costs of compartmentalization are borne by the GOB and donors, the recurrent costs should be met from a more secure and appropriate source. CPP will collect extensive information and based on such data and the actual experiences in CPP and present recommendations in 1995.

Apart from recommendations on the various policy issues associated with compartmentalization, CPP has developed a training package to support the institutionalization process at field, sub-compartmental and compartmental level. After field testing and fine-tuning, the training materials and methods will be presented for replication in similar settings in other parts of Bangladesh.

3.4 Development adjacent areas

Compartmentalization takes into account the affects of the project on adjacent areas. This is done both for reasons of equity and to secure the sustainability of the project by preventing sabotage by people from outside. To achieve this the general principle is to mitigate any negative impact from the project.

In the long run compartmentalization of the adjacent areas may be the best possible "mitigation". As this depends on the viability of the present compartments, such a scheme is not yet guaranteed, and even if compartmentalization is found to be viable and replaceable, it can take quite a while before the turn of the adjacent areas has come. For that reason mitigation of the negative impacts of compartmentalization executed over the coming years, is targeted.

It should be pointed out that the area outside the (retired) BRE is not considered to be part of the CPP. This area is particularly affected by the main embankment and mitigation measures should therefore be part of the project/programme that takes care of the main embankment.

Apart from the physical mitigation measures, much attention will be given to institutionalizing the input from people in the adjacent areas in the compartmental decision making process. People from those areas will be represented on the Compartmental Water Management Committee. There they can voice their needs and influence the decisions regarding the operation of the compartments in- and outlets.

In the coming years CPP will investigate the possibilities of developing compartments in adjacent areas. In addition the linkages between future compartments will be established.

4 PLANNING AND DESIGN CRITERIA

4.1 General

The planning for CPP *Sirajganj* should be developed in the line with the objective of the project as defined in the ToR

> *"... to establish appropriate water management systems for the development of protected areas so that criteria and principles of design, implementation and operation can be made available for the Action Plan".*

A number of possible options within the framework of a compartment for the CPP area is established with a set of design criteria which in part are specifically developed for this area.

4.2 Development components

4.2.1 Flood Protection

Flood protection measures are measures which are taken for the protection of certain areas and are necessary due to flooding caused by:

1) a local BRE breach on the boundaries of CPP *Sirajganj*;
2) major runoff as a result of local rainfall upstream of the CPP *Sirajganj*;
3) backwater (or backflow) effect from the *Karatoya* river back into the *Ichamati* river and *Baniajan* river;
4) any combination of the above three.

4.2.2 Breach Mitigation

Breach mitigation measures are those which can cope with the impact of breaches occurring as a result from the erosive power of the *Jamuna* river. These breaches are a result of a direct BRE breach which occurs in the eastern boundary of the CPP area.

In physical terms this means that the actual impact of a breach occurrence is mitigated through the construction or upgrading of roads which serve as embankments. Also the water control structures need to be constructed for control of excess floodwater to be conveyed from the SC's to the drainage system.

These roads/embankments confine the floodwater to a certain area (one or more subcompartments depending on the magnitude) and subsequently the excess floodwater will be conveyed through waterconveyance structures to the drainage system. These crucial roads cum embankments should be sufficiently stable and designed according to special design criteria.

4.2.3 Drainage Improvement

Drainage congestion in pre-monsoon and post-monsoon within the context of the existing infrastructure is one of the constraints in further developing the area with an improved water resources control which should lead ultimately to increased agricultural production.

4.2.4 Compartment Watermanagement

The flood water will flow into the compartment and spread over the area in a (semi)-controlled way by means of regulating structures in the primary embankments along the *Jamuna* river and the gated or ungated openings in the secondary embankments between the compartments The structural and non-structural measures to achieve this can be called the macro (main) system.

The way the flood, as well as the drainage of excess rainfall, has to be controlled will be determined by the demands from inside the compartment. The required structural and non-structural measures for water management within the compartments can be called the micro system.

The concept of compartmentalization is instrumental for the implementation of water management interventions.

4.2.5 Water Retention

Water retention may play a considerable role in the overall watermanagement practices in the CPP area. The main reason is that especially in the (post-)monsoon season, water retention measures may by performed by:

- the construction of bunds on the fields
- by actual construction of water retention structures located in a depression, khal or existing beel in order to create a storage of surface or subsurface water.

4.2.6 Mitigation Plans For Adjacent Areas

The impact of the implementation of project interventions can be noticed in the adjacent areas. This is measured in terms in terms of rise in water level resulting from the operation of control structures and construction of proposed embankment. The negative impact of measures caused by the project for the compartment itself, and those bearing a negative impact on the adjacent areas, need be mitigated. These mitigation measures are to be translated to the various disciplines and converted into action plans. The mitigation plans for the adjacent areas are:

- raising rural roads, markets and homesteads
- re-excavation of the *Ichamati*
- building of an *Ichamati* Right Embankment

4.3 Options for development

4.3.1 Results of people's opinions

In order to assess the water related needs of the people of the area a Needs Assessment Survey has clearly indicated a number of issues which the people in certain locations would like to see solved within the project context.

The actual results of the Needs Assessment Survey were evaluated in an interdisciplinairy mode such that packages were developed which were as much as possible agreeable with people's opinions in the area. These packages (or development options) are a first attempt to translate the people's opinion in a holistic and realistic framework at compartmental level.

In these surveys, it is noted that both quantity and quality of actual peripheral regulators in the BRE is not sufficient to fulfil the needs.

The people living near the *Ichamati* river complain about drainage congestion as a result of:

1) high river waterlevels coming from the upstream areas north of the CPP *Sirajganj* boundary which then consequently inundate the areas adjacent to the river; this high waterlevel can be caused by a BRE breach upstream of the CPP *Sirajganj* or by local rainfall runoff:

or;

2) a backwater (or backflow) from the *Karatoya* river back into the drainage system of CPP.

It is also mentioned that a BRE breach within the compartment has sometimes caused these drainage congestion problems near the *Ichamati* river.

4.3.2 Development options

As part of this planning exercise which forms the basis for future elaboration, design and implementation it is necessary to identify a number of options which are amongst the most feasible to implement within the project framework. Taking into account the overall likely development of CFD projects in the region, agricultural, hydrological, economic and social aspects are to be consistently identified and weighted in these options. Although at this time it is not possible to weigh these factors in a consistent framework, the importance of these factors should be taken into account in general terms.

The following options for development are discussed:

OPTION 1:	COMPARTMENTALIZATION PROJECT SITUATION WITHOUT AN *ICHAMATI* EMBANKMENT
OPTION 2A:	COMPARTMENTALIZATION PROJECT SITUATION WITH THE *ICHAMATI* EMBANKMENT ALIGNMENT I (EXISTING ROAD)
OPTION 2B:	COMPARTMENTALIZATION PROJECT SITUATION WITH THE *ICHAMATI* EMBANKMENT ALIGNMENT II (ROAD ALONG RIVER BANK)

In OPTION 1, 2A and 2B a major breach in the BRE is not expected due to assumed proper sealing of the BRE. However, it should be noted that NO absolute guarentee can be given to this in spite of an eventual BRE sealing/repair performed.

The difference between OPTION 1 and OPTION 2A-2B is that for OPTION 2A and 2B an embankment along the Ichamuti river/khal is foreseen. Flooding measures are in principal taken in relation to the flooding from the *Ichamati*-river/khal/branch.

4.3.3 Description of the Present Situation

The CPP is bounded on the east by BRE, on the north-west by the *Ichamati* khal, on the west by the *Ichamati* river and on the south by the New *Bogra* road. The flow pattern of this project is influenced by the mighty *Jamuna* river, the *Ichamati* khal and the *Ichamati* river.

The *Sirajganj* compartment is situated behind the *Brahmaputra* Right Embankment (BRE) and therefore largely depends on the quality of the BRE. The objective of the BRE is to protect the land behind the embankment from flooding.

An additional complication is formed by the runoff quantities conveyed by the *Ichamati* river which originates from the upper catchment. Inside the compartment, the *Baniajan* river and *Ichamati* branch are the only rivers that flow through the compartment.

4.3.4 Common Features of the Development Options

All these options include improved drainage, construction and/or rehabilitation of (BRE) inlet structures, water retention structures, and internal water management control structures.

In general, the options provide features for a watermanagement system in the CPP area which assumes that the status of the BRE is sufficiently stable. The term stable BRE is referred to as a situation whereby it is expected that the actual embankment will not breach until a 1:100 years waterlevel. However, the 1:100 years maximum waterlevel is a subjective indication due to the other factors which are actually involved in a breach occurrence.

In case there is a direct breach in the CPP area, the following approach is suggested:

1) confine incoming BRE breach floodwater to a restricted number of subcompartments depending on the magnitude of the breach and
2) convey these floodwaters adequately and quickly through water regulators in the subcompartment boundaries to improved drainage canals.

The main drainage system within the compartment is proposed to be improved. A drainage diversion regulator is proposed which receives incoming water from the adjacent areas north of the CPP compartment. This drainage diversion regulator diverts incoming water to the *Ichamati* khal in order to keep the inside drainage system as empty as possible. In other words, the *Ichamati* branch capacity will be available for drainage water from inside the compartment. Any major waterflow which originates from the area north of the compartment will only partially enter into the compartment area and will be diverted through the Ichamuti khal to the *Ichamati* river.

The inlet structures at the BRE will either be improved or reconstructed and access canals will be maintained for proper access from *Jamuna* water to the BRE. The purpose of these inlet structures is mainly directed to supplementary irrigation and in relation to incoming fish fry.

The internal watermanagement have as purpose to regulate the waterresources entering and exiting the subcompartments such that the waterlevels are carefully balanced for the proper allocation in time and space.

For the development of *Sirajganj* town, it is proposed that the main drainage canal (Baral river) needs to be re-excavated from its intake at the BRE upto the Hurasagar river with the provision of one (or more) flushing sluice at its intake for flushing purposes. Existing culverts need to be modified to increase their flowing capacity and new culverts need to be constructed at suitable locations. The existing internal drainage system within town also needs to be improved to remove waterlogging. Existing drains are inadequate in size, length and number.

Erosion protection works are proposed to protect the existing roads and other infrastructural items from erosive forces which are a result of fast increasing waterlevels or high waterlevels. Especially adjacent to waterregulating structures it is necessary to assure sufficient protection.

Fieldlevel watermanagement measures need to be taken regarding the control of water within a subcompartment to regulate the waterlevels in certain uniform areas (chawks) within the subcompartment.

The various features of the three options are summarized below:

Main features of the development options

FEATURES	OPTION		
	1	2A	2B
Flood protection from *Ichamati* back into CPP area	-	*	*
Embankment along existing roads	-	*	-
Embankment along river bank	-	-	*
Improved Drainage	*	*	*
Inlet structures at BRE	*	*	*
Structures at *Ichamati* branch and khal	*	*	*
Structures at Subcompartmental Boundaries	*	*	*
Structures at *Ichamati* East embankment	-	*	*
Water retention structures	*	*	*
Construction of structures which regulate inlet/outlet from subcompartment to subcompartment/khal.	*	*	*
Diversion of major quantities of drainage water which comes from north of the CPP-project area through the *Ichamati* khal/branch	*	*	*
BRE breach control works	*	*	*
Sirajganj town flushing inlets	*	*	*
Erosion protection works (related to structures)	*	*	*
Field Level Watermanagement	*	*	*

4.3.5 Option 1

DESCRIPTION OPTION 1:

COMPARTMENTALIZATION WITHOUT THE *ICHAMATI* EMBANKMENT

This option consists of improved drainage, construction and/or rehabilitation of (BRE) inlet structures, water retention structures, BRE post-breach control, irrigation and internal water management control structures (See Option 1 map in the back of this volume).

ADVANTAGES OPTION 1

This option is developed from the point of view that regional benefit prevails over local disbenefit. The risk of any major flood originating from a BRE breach in the CPP area will be confined to one or more subcompartments according to the severity and duration of flooding . The accumulated floodwater will be conveyed through regulators to major khals/rivers. For this purpose, three new large regulators will be constructed in SC 3 while in case of a breach for SC 5, existing and new infrastructure and will convey the floodwater to khals/rivers.

A considerable improved wate management system in comparison with the existing situation will regulate the inter al (inter and sub-compartmental) water management. The expected benefits are in terms of more sustainable agricultural and fisheries production.

The functioning of improved BRE regulators will largely depend on the *Jamuna* course and its pattern of erosion. Tha in turn will influence the potential for floodplain fish development and the potential o allow irrigation water to enter the compartment.

DISADVANTAGES OPTION 1

Depending on the magnitude and duration of flooding from the BRE, it is estimated that the affected areas within the CPP area will substantially suffer from the breach and that most probably the areas will s ffer in agricultural terms.

It is also expected that areas o the *Ichamati* left bank will suffer from extended flood levels in case of high water le els caused by a BRE breach in the upstream areas of the CPP *Sirajganj* and/or excess r infall in the uptream catchment area. A mitigation plan will reduce the extent of this damage.

4.3.6 Option 2A

DESCRIPTION OPTION 2A :

COMPARTMENTALIZATI ON PROJECT WITH *ICHAMATI* EMBANKMENT SYSTEM ALIGNMENT I (EXISTING ROAD SYSTEM)

This option consists of measures for flood protection, improved drainage, construction and/or rehabilitation of (BRE) inlet structures, water retention, BRE post-breach control, irrigation, internal watermanagement control structure, and Ichamuti embankment (Alignment I). In this option a alignment is proposed which follows existing infrastructure (See Option 2A map in the back of this volume).

Comparing Option 2A and Op ion 1, there is an addition of the OPTION 1 situation by including an embankment alon the *Ichamati* river/khal. The purpose of this embankment is to protect the *Ichamati* left bank from flooding due to drainage congestion.

ADVANTAGES OPTION 2A

Besides from the already ment oned advantages for Option 1, the additional advantage for Option 2 A will be the embank nent on the left bank of the Ichamuti river which will prevent major backflow from the Ichamuti river back into the CPP area. The alignment of the *Ichamati* embankment is in this option proposed to follow a partially existing road sytem and therefore most prob: oly will cause less constraints in actual land acquisition.

DISADVANTAGES OPTION 2A

Due to the construction of the embankment along the *Ichamati* (Alignment I), it is expected that certain localized areas on the Ichamuti left bank will suffer from extended flood levels. A mitigation plan for land holders located between the proposed embankment and the *Icnamati* river/khal is to be specified for this purpose.

Furthermore, an embankment on the left bank of the Ichamuti may cause local drainage congestion on the Ichamuti river right bank. However, one should also realize that the allocation of the Ichamuti left embankment allows for sufficient drainage water to be stored along the river in its immediate floodplain. The location of the embankment road is NOT immediately adjacent to the current river course.

4.3.7 Option 2B

DESCRIPTION OPTION 2B:

COMPARTMENTALIZATION PROJECT WITH ICHAMUTI EMBANKMENT ALIGNMENT II (ALONG RIVERBANK)

This option consists of measures for flood protection, improved drainage, construction and/or rehabilitation of (BRE) inlet structures, water retention, BRE post-breach control, irrigation, internal watermanagement control structures and *Ichamati* embankment (Alignment II).

In this option an alignment is proposed which actually follows the Icahmuti river bank closely.

ADVANTAGES OPTION 2B

Besides from the advantages mentioned in Option 2A, it needs to be mentioned that an alignment close to the river banks will minimize the areas between the river and the embankment and thus minimize the affected areas which suffer from flood levels. Consequently the area inside the compartment which is hereby negatively affected, is hereby reduced in size in comparison to Option 2A.

DISADVANTAGES OPTION 2B

The new alignment of this embankment and the location and implementation of embankment cum road along the Ichamuti river and khal may cause considerable difficulty, from a land acquisition point of view. This alignment is almost completely new and considerable landacquisition is required.

The area on the right bank of the *Ichamati* will be affected more than in Option 2A. Mitigation measures are proposed for this area.

4.3.8 Conclusions

The overall overriding factor in this compartmentalization concept as present in CPP *Sirajganj*, is the BRE. The strength and the overall impact of the BRE on the region and in particular on the CPP area dominates the outcome of an option analysis.

Although the BRE itself is under direct responsability of the O&M Division of the BWDB, the impact of a (mal)functioning of the BRE is felt directly in the CPP area. Almost all decisions at farm, district and regional level are linked to the functioning of the BRE. From the available reports from FAP and other sources, it is not clear which measures are being taken to combat the erosive and destructive force of the *Jamuna* river. Several possibilities for improvement and stabilization of the BRE are being studied from FAP/GOB point of view but no decision or systematic plan has been put forward yet.

However, the scope of CPP does not include the physical control, operation or rehabilitation of the BRE as explained previously. In order to build up CPP properly from its foundations, for obvious reasons the factor BRE has to be included in it. It is therefore suggested that collaboration with other FAP-projects which work on a regional/national scale is put into practice. It would be preferable to be linked with a project which has a direct implementation component in which CPP *Sirajganj* area directly or indirectly can benefit from an improved BRE functioning.

It is understood that such an effort will be time-consuming. In order to bridge this time gap between the present situation and an eventual improvement of the BRE performance at regional scale, the development, design and implementation of options which are acceptable and practically feasible within the scope of "breaching BRE possible" should be initiated.

Moreover, BRE post-breach management very definitely must also include the resource allocation to repair major damages caused by a BRE breach. This resource allocation should come from the present organization in charge of the BRE construction and maintenance (BWDB). On the long term, a regionally or nationally operating (FAP) project should make the necessary funds available for a more consistent and general solution of the BRE breaching. The necessary financial and other resources need to be adjusted and allocated accordingly.

Comparing the presented options, it is obvious that OPTION 1 alleviates any impact of a BRE breach while the other options in addition do provide measures which also protects the Ichamuti left bank from flooding (OPTION 2A,2B). The way in which this will be implemented is different. OPTION 2A provides an entire embankment which can also be used as inspection road, likewise OPTION 2B. Experience with the BRE retired embankments has taught that land acquisition can form a major obstacle in the construction of this protection measure. OPTION 2A tries to avoid land acquisition as much as possible by using existing infrastructure; subsequently upgrading is performed to

the proper design embankment level. Furthermore, OPTIONS 2A and 2B provide an improved inter and intra compartmental water management which allows for considerable agricultural production increase through the use of regulating structures at subcompartment boundaries.

The functioning of improved BRE regulators will largely depend on the change of the *Jamuna* course and its pattern of erosion. That in turn will influence the potential for floodplain fish development. However, the relatively minor quantities of fish fry will not impact the existing situation considerably, unless culture fish is being introduced systematically. However, under the given conditions, this development is not very likely due to the sandy soils in many parts of the CPP.

Given the status of the BRE at present and the assumption of a stable BRE, the presented options 1, 2A and 2B establish a compartment whereby the concept of compartmentalization can be fully tested. Along with the establishment of structural measures, non-structural measures also need to be developed within the time frame avialable. At the end it should be possible to operate the compartment and test the watermanagement as envisaged in the ToR.

4.4 Non-structural interventions

4.4.1 People's participation in Sirajganj CPP

To achieve sustainable development through water management the FAP 20 ToR puts much emphasis on people's participation and its institutionalization:

> *"The compartment is basically a management unit in which the involvement of beneficiaries is considered essential for its success"*. [ToR,p.3].
>
> *"The non-structural output which constitute the basic objectives of the Pilot Project will cover the following:*
> .....
> *2. Social Aspects*
> *Policies and Guidelines of involving the scheme beneficiaries and disadvantaged groups in the planning and implementation of physical works and their management ...*
> *4. Institutional Arrangements*
> *Policies and Guidelines for strengthening existing institutions and/or establishing new ones for the management of compartments or sub-compartmental development with the emphasis on local government and beneficiary participation* ... [ToR p. 6, 7].

This emphasis on involving the affected people in all aspects of compartmentalization has been strongly reconfirmed by evaluations of existing FCD/I projects (see particularly FAP 12/13). These have highlighted that, success and sustainability require people's participation throughout the project,s life cycle. FAP 20 has therefore designed a

comprehensive programme involving all concerned in the process of designing and testing compartmentalization.

4.4.2 Needs assessment

The FAP 12/13 and other evaluations have shown that, whether or not the project will be sustainable, depends to a large extent on whether it addresses the needs of the people. To find out the perception of the different interest groups about the existing water management related situation the problems as they perceive them and their ideas about potential solutions, a needs assessment survey has been carried out in *Sirajganj* CPP.

This needs assessment survey at village level involved farmers, fishermen, landless, women and in the town urban people. The survey has been conducted in up-stream areas as well as in the adjacent *Ichamati* river floodplain.

4.4.3 Completed and planned consultation meetings about technical interventions

On the basis of the project objectives and the findings of the needs assessment a detailed development plan has been drawn up for the area. During a period of one month meetings were held with one group of each of the different interest groups in each sub-compartment. All the relevant UP members were brought together for a meeting where the proposed interventions were explained and their reaction sought. A separate meeting was held with the *Pourashava* officials to discuss the plans.

The reaction of the public and officials were recorded and where possible and necessary the original plans were adjusted.

4.4.4 Landless Contracting Societies

Much earth work is planned for the re-excavation of existing *khals* and for repairing embankments. Of this work 0-50% has been reserved for Landless Contracting Societies. FAP 20 has drawn up rules and regulations for such LCSs in line with those already approved by BWDB for SRP. It is clear that such LCS's require a level of administrative work that few existing groups of landless are used to. Therefore FAP 20 will help the target group to get organized and registered so that they can in due course make use of this employment opportunity

This facilitating work will start as early as possible so that the necessary administrative and legal matters can be fulfilled within the time frame provided by the rules and regulations.

4.4.5 Policies and guidelines

Based on the experience in Tangail and *Sirajganj* CPP to date, tentative policies and guidelines will be drafted, covering the planning and design phases of compartmentalization. As the project unfolds, these guidelines will be further expanded

and fine-tuned. By the end of the project, these policies and guidelines will be the final output of FAP 20.

4.5 Institutionalization Programme

4.5.1 General

The main objectives for CPP's institutionalization programme are:

(a) creating and testing mechanisms for the direct involvement and representation of the various interest groups concerned with water management in decisions and actions affecting their related interests;

(b) creating and testing mechanisms for direct and continuous exposure and support of the various government agencies concerned with effective use of land and water as well as local government structures and relevant NGO's;

(c) strengthening individual and collective interest and capabilities to deal with water management issues among selected governmental and non-governmental agencies at field, thana and district level;

(d) testing of institutional arrangements for integrated area-based water management at compartmental and sub-compartmental level and preparation of recommendations and guidelines regarding possible long-term institutional provisions in this regard;

(e) exploration of financial and practical aspects of water management at compartmental and sub-compartmental level and preparation of recomendations regarding options for cost-recovery and decentralization of Operation and Maintenance responsibilities.

Initial surveys have been conducted in *Sirajganj*, which are reported in Section 2.5.6. A high level of interest was found among governmental and non-governmental agencies. The Institutionalization Programme will initiate activities to establish appropriate institutions at three levels: field, sub-compartmental and compartmental level.

After a summary sketch of the envisaged institutional arrangements the following sections will provide a brief description of these three levels, elaborated in much detail in Annex 7 Institutional and Training Aspects.

This description will first discuss the proposed approach to support the lowest level, the Water Users Groups (4.5.2), after that the Sub-Compartmental Water Management Committee (4.5.3) and finally the highest level: the Compartmental Water Management Committee and its predecessor: the *Sirajganj* CPP Steering Committee (4.5.4). A summary of the supporting training activities will be discussed in Section 4.5.5.

Table 4.1: Proposed Institutional Arrangements

	beneficiaries	*technical departments*	*local government*
field level	water users specific interests: a) farmers b) fishermen c) landless d) women	assisted by field staff, esp.: DAE BS'S, BRDB BI's, occasional BWDB & LGED staff	Union Parishad
organised by field staff and group organisers (who are selected, trained and supported by CPP) into:	WATER USERS GROUPS defined by functional and socio-economic interests: a) farmers from chawks, organized by DAE b) fishermen from their associations c) landless from existing BRDB and NGO groups d) women from existing BRDB and NGO groups		
sub-compartment level	approx 7 repr. of interest groups for: 3 from farmers 1 from fishermen WUG 1 from landless WUG 2 from women WUG	3 field staff: DAE & BRDB and where present: BWDB and LGED: and 1 NGO representative	3 Union Parishad members: of wards dominating within sub-compartment
organised by CPP and field staff of NGO, BRDB & DAE into:	SUB-COMPARTMENT WATER MANAGEMENT COMMITTEE		
compartment level	One representative of each SCWMC,	approx. 7 dt level gov. staff, 2 NGO representatives	1 ADC appointed by DC and 1 Pourashava Chairperson
organised, trained and supported by CPP into:	later: COMPARTMENT WATER MANAGEMENT COMMITTEE		
	but at first: SIRAJGANJ CPP STEERING COMMITTEE:		
	composed of: * 7 district level staff of various GOB departments/boards * 4 representatives of functional/socio-economic interest groups, via existing organisations; (farmers, fishermen, landless, women) * ADC for DC; * *Sirajganj* Pourashava Chairman; * CPP Project Director and Team Leader		
district, regional and national evel	(so far no institutions for multi -disciplinary water management)		

4.5.2. Water Users' Groups

The lowest level of the institutional setting for water management will be at the level of Water Users' Groups (WUG)

After the establishment of the Steering Committee priority will be given to the organization of these groups, which subsequently will become the foundation of the SCWMC's: representatives from the WUG's are expected to form the major part of membership of the SCWMC's.

The organization of groups can be a demanding and time consuming affair. The people of the area are asked to contribute time and money, directly, or indirectly as travel and lost income opportunity, willingness to abandon individual freedoms (need to compromise and coordinate actions with others), to assume responsibilities, etc. Thus the water users and CPP should aim for an efficient, time and cost effective mechanism for the organization of water users' groups.

An analysis of the interests in and possibilities for water management at field level, presented in Annex 7, leads to the conclusion that water management per se, except for irrigation, appears to be too limited an issue to sustain groups that regularly convene and build up a cohesiveness. The interests are summarized in the below Table 4.2.

Table 4.2: Description of relative interest in operation and maintenance by group

	operation-	maintenance-
farmers	- day-to-day - seasonal	- direct
fishermen	- seasonal	- direct
landless	- seasonal	- direct - indirect (employment)
women	- day to day(varying) - seasonal	- direct - indirect (employment)

A well informed and task oriented organization for water management at field level is required, both for operation within the limits possible, and to come to effective representation in SCWMCM's and CWMC. However, CPP will not establish WUG, for the sole purpose of water management. Organized groups already exist in the project area and can possibly be interested in CPP activities. Simultaneously new groups will have to be organized, for instance among the farmers, on the basis of a common interest that includes water management issues.

The approach to be followed by CPP will include the following features:

- no-single purpose water users' groups
- utilize existing groups as far as possible
- different degrees and ways of support to the different interest groups

- site and situation specificity
- phasing of activities
- cooperation with other agencies

The different degrees and ways of support to the different interest groups suggested by the inventory results, suggest the approach as outlined in Table 4.3:

Table 4.3 Outline of the approach to organization of WUG's

	establish new groups	rely on existing groups	required CPP input
farmers	yes	yes	high
fishermen	no	yes	medium
landless	no	yes	low
women	no	yes	medium

CPP will, as much as possible, cooperate with other organizations, building upon specific strengths and mutual interests, to establish or support multi-purpose groups that can serve as water users' groups for the CPP. This will be both cost and time effective, and enhance possibilities of sustainability.

In this process of institutionalization, specific support will be given to women as users, contributors and beneficiaries of good water management.

CPP will not establish single-purpose water users' groups. Instead the following programmes are proposed, to be implemented simultaneously:

a. organization of water users'/farmers' groups;

It is almost impossible to separate water management and agriculture. The establishment of multi-purpose groups, here farmers'/water users' groups, in cooperation with DAE, will be to the mutual benefit of both CPP and DAE. DAE is presently reformulating its approach to agricultural extension. The Training and Visit system, and the contact farmers' approach are being replaced. The new extension methodology will concentrate on farmers' groups focusing on technology (e.g. irrigation, homestead vegetation etc) based on local conditions and means. In close cooperation with DAE and its block supervisors who deal directly with farmers, a fruitful combination of farmers' groups and WUG could be developed, broadening agricultural extension to include farm water management and planning.

Delineation of groups, and the required efforts to support them should be site and situation specific. Probably the chawk is the most suitable unit a farmers'/water users group. Chawks are blocks at field level, usually bordered by embankments, roads, villages, or other recognizable physical entities. Chawks are usually closed areas. Chawks are known by names by the local people. They appear to be existing entities recognized

by the population; entities with physical boundaries and generally acknowledged common interests.

Still, the practicalities for each chawk/group will have to be assessed in the field, keeping such factors in mind as group size, existence of irrigation groups, soil and hydrological conditions, and administrative and socio-cultural factors.

b. organization of water users'/fishermen's groups

The group of professional fishermen could, most efficiently, become involved in water management by strengthening the existing associations so that water management is explicitly included in their tasks. In paying sufficient attention to the needs of the professional fishermen in the area, also the requirements of the subsistence and part-time fishermen need to be covered. The women in development personnel will assist in mobilizing women's involvement in the development of aquaculture activities that can mitigate the implications of changes in fish availability for household food security and diversity in terms of protein.

The contracting of a special team is proposed, as outlined in the report 'Mitigation Measures for Fisheries', including among others an extension/credit specialist and extension workers. As fishermen will be involved in principle through already existing and functioning associations, activities in the field of organizing water users'/fishermen's groups are not required. Extension staff should pay more attention to strengthening of these fishermen groups/associations so they can coordinate and voice the interests of fishermen in water management.

The extension staff of farming and fisheries activities will be trained jointly in methods of group organization, as well as in the implications of compartmentalization measures and systems for water management. This arrangement could further result in better informal coordination at field level.

Project financed extension staff will, apart from sharing technical knowledge, pay explicit attention to the need to establish an efficient and sustainable mechanism for liaison between DOF and fishermen's groups, because their presence is only temporary.

c. organization of water users'/landless groups

NGO's have organized 2212 groups of landless in the project area BRDB and 231 by BRDB. Instead of organizing new landless groups at field level for the specific purpose of water management, active existing groups should be supported to pay attention to aspects of water management relevant to their specific situation.

Focus of the approach will be on informing and guaranteeing representation in the SWCS's and CWMC as a means for landless to defend their interests wherever necessary. Training and information for group organizers and other staff of NGO's and BRDB will be provided on the technical and institutional aspects of water management in CPP.

d. organization of water users'/women's groups

The organization of water users'/women groups will follow the same lines as described above for landless and fishermen. 1575 women's groups exist in the area, most of them organized by NGO's. Women's groups will be supported in activities of flood proofing to saveguarding food, fuel and fodder as well as ensuring adequate water allocation for save drinking water supply, sanitation, hygiene.

Obviously there is a common farmers interest for water in the field. Still, representation of interests arising from homestead gardening, seed and crop processing needs, needs to be ensured. Usually women are responsible for the latter tasks. The project will specifically support women groups in technical aspects of water management and provide training aiming at a strong representation of women's interests in the future SCWM's and CWMC.

Separate programmes for the organization of different groups of water users' are proposed. These programmes should run simultaneously and be inter-linked as much as possible. The different agencies to be involved in actual implementation are defined and a broad indication of responsibilities of each agency has been given (See Annex 7).

4.5.3 Sub-Compartmental Water Management Committee (SCWMC)

The next level, possibly covering the needs of the widest range of users, is that of the sub-compartment. Here the project will stimulate the creation of a Sub-Compartmental Water Management Committee. This is the institution that will be in charge of water management for the sub-compartment and it will be the most important one for the articulation and representation of specific interests. These are, of course, the interests as defined and felt by the Water Users Groups of the various categories. Water regulation influencing the homestead might be particularly crucial at this level. Women's interest must therefore be ensured and their representatives must become effective. The envisaged composition and major tasks of the committee are outlined in Table 4.4.

It is important to emphasize that the Sub-Compartmental Water Management Committees will only be established once the Water Users groups are identified, organized and trained. This is because the committee will reflect **their** interests and will build upon their initiatives. For a positive start of these committees it is essential that they have a functional and decision making role to play. This implies that design and construction of the concerned sub-compartment should have started, so that the new committee will be able to make and enforce decisions regarding water **management.** For this it needs structures that can be regulated. But also the other way round: regulatory structures should not be finalized before the concerned Sub-Compartmental Water Management Committee is in place. This could imply a delay in the placement of the gates.

It is often thought that the responsibilities of women are so restricted to the privacy of the home that it is not necessary to include them in public planning processes, but this is a fallacy. The same fallacy is found in thinking that women are one group with the same needs and interests, that fall outside farming and fisheries group interests, just because women need to be approached separately.

Table 4.4 Outline for Sub-Compartmental Water Management Committee

Members	Membership:	Comments:
7 or 8 members from interest groups:	3 farmers 1 female homestead farmer 1 fisherman 1 landless (likely to be female) 1 or 2 woman (1 urban dweller)	* 2 out of 3 farmers should be small farmers (<2.5 acre). * Special functional group can be invited * Urban dweller only where applicable. * There are more female than male landless groups in Serajanj.
up to 3 members from concerned government departments + BWDB, if involved.	Ex officio members: 1 Block supervisors DAE 1 Block inspectors BRDB 1 BWDB if involved in the SC 1 LGED staff if involved in SC	* From concerned area. * BWDB representative only if active there.
3 members from local government:	3 ward members of Union Parishads	One ward member from each concerned ward
1 member from NGO active in area	1 NGO representative	Most active in area
membership total:	11 to 14 members	may fluctuate
chairman:	UC Ward member or Chairman	experimental

Roles of the Sub-Compartmental Water Management Committee

A: planning and operation of structures
1 determine seasonal O&M guidelines
2 supervise operation and maintenance of all structures
3 advise on all government inputs related to water management
4 monitor all government action related to water management
5 establish and supervise structure committees where required

B: advice and supervision of water management
1. advise on location and design of sub-compartment
2. advise on water management of the sub-compartment
3. settle conflicting interests

C: mobilisation of resources	1. assist in establishing users groups 2. negotiate with LGED/BWDB on contributions 3. mobilize labour input for construction and excavation 4. control local funds for minor structures 5. handle or advise on FCD tax to Union/Thana (if introduced) 6. advice to Union and Thana on water related budget 7. participate in training
D: representation to other levels:	1. interest group members represent users groups 2. ward members have dual role to supply info to sub-compartment committee and UP monthly meetings 3. DAE/BRDB block staff feed info to Thana level 4. SCWMC Chairman is member to CWMC as representative.

4.5.4 Compartmental Water Management Committee and Steering Committee

At the highest level (at least as far as the compartment is concerned), CPP will help to establish the institution that will be in charge of water management and O&M at that level. Below an outline is given of this body. From this outline it is obvious that such an institution cannot and should not be established overnight. First of, there should be social and political support for such a new structure, which will affect existing agencies and possibly redistribute administrative arrangements.

Such support should primarily be based upon users requirements: compartmental water management by various interest groups should have proven to be possible. The various lower level institutional arrangements are effective in articulating and representing their interests upwards.

In practical terms this means: Water Users Groups and the Sub-Compartmental Water Management Committees should effectively exist. As they will be represented in the envisaged Compartmental Water Management Committee. Therefore, their actual existence is a pre-condition. Active support is equally required among the technical department and local government structures, whose programmes and initiatives will be affected by Compartmental Water Management. They should have become familiar with and have established representation in lower level water management institutions.

Secondly, there should be sufficient justification in terms of the benefits and operational requirements of compartmental water management before the organisational and operational investments are made. Only when compartmentalization will have been an operational reality in *Sirajganj* and Tangail, this condition will be met.

Lastly, there should be some clarity about the long term institutional arrangements around compartmental water management. As outlined earlier, the water users institutions at various levels will need to become registered with a governmental agency through which the administrative, legal and financial procedures will be defined. It will take time before CPP (or more generally: FAP) reaches that stage, although this pilot project will formulate recommendations on these issues.

RESPONSIBILITIES:	
1. Determine arrangements and ground rules for water management at compartmental level	Within regional or national parameters
2. Supervise and implement O&M at compartmental level	Execute through BWDB/CPP?LGED personnel
3. Promote and facilitate inter-agency collaboration	Esp. at district and thana level
4. Promote, assist and advise SCWMC's	To ensure proper functioning SCWMC's
5. Settle disputes between SCWMC's	Applying general guidelines
6. Advise on long-term institutional arrangements for compartmentalisation	Esp."incorporation" into existing GOB structures
7. Review CPP progress and give guidance to Project Team	As long as CPP continues
8. Represent *Sirajganj* Compartment to higher levels	

As explained the *Sirajganj* CPP Steering Committee will precede the CWMC and it will be established upon instruction of the FPCO. By then the informal contacts with the various agencies should be intensified and regularized. A seminar-cum Participants-Activities Matrix conference, similar to the one conducted in Tangail can help to increase understanding of, and interest in, CPP. And it can be the kick off point for the Steering Committee. The broad outline for this Committee is as follows:

Composition of the CPP Steering Committee and it's role

Steering Committee:

Sl.No.	Designation	Representing Depts./Agencies & identity
1.	Chairperson	Project Director/Superintending Engineer, CPP: FAP 20
2.	Member	Chairperson, *Sirajganj* Pourashava
3.	Member	A.D.C. nominated by the D.C., *Sirajganj*.
4.	Member	Deputy Director, DAE, *Sirajganj*
5.	Member	District Fishery Officer, *Sirajganj*
6.	Member	Deputy Director, BRDB, *Sirajganj*
7.	Member	Executive Engineer, LGED, *Sirajganj*
8.	Member	Executive Engineer, R & H, *Sirajganj*
9.	Member	Executive Engineer (O & M), BWDB, *Sirajganj*
10.	Member	Dist. Livestock Officer, *Sirajganj*.
11.	Member	Director, Dip Shetu, Sirajganj proposed-(NGO representative in *Sirajganj*.
12.	Member	Director BURO, Sirajganj proposed-(NGO representative in *Sirajganj*).
13.	Member	Executive Engineer (Irrigation), BADC, *Sirajganj* (south).
14.	Member	Team Leader Consultants Team, CPP

While there are valid reasons to be cautious in establishing the Compartmental Water Management Committee, CPP needs a mechanism for the facilitation of inter-agency co-operation, guidance and review of the project, mediation of conflicts and for most practical matters. So, the project propóses to establish a *Sirajganj* CPP Steering Committee. This temporary committee will precede the ultimate Compartmental Water Management Committee, and will look after those responsibilities that can be handled by such a temporary body. This means that the Steering Committee will not have the formal and final status of the CWMC.

There will be another major difference between the CWMC and the Steering Committee, in relation to the phase of the project. The interest groups will be present, once WUG's and especially SCWMC's will have been formed, and become the official channel for representation of beneficiaries. This will take time and meanwhile the beneficiaries still need some form of representation. This will be solved by making a temporary provision for the representation of the four interest groups: farmers, fishermen, women and landless.

Table 4.5 Main Characteristics Sirajganj Compartmental Water Management Committee

Outline of *Sirajganj* Compartmental Water Management Committee		
Members		Comments
Dep.of Agricultural Extension	Deputy Director Sir.District	
BRDB	Deputy Director Sir. District	
LGED	Executive Engineer Sir.District	
Dep. of Fisheries	Dist. Fisheries Officer	
Roads & Highways	Executive Engineer Sir.Dt.	To be reviewed
BWDB	Exec.Engineer O&M Div.	
Dep. of Livestock	Dt.Livestock Officer	To be reviewed
Other departments	Incidental invitation	
Pourashava	Pourashava Chairman	
NGO's	Two representatives	To be selected by NGO's
CPP	Project Director	Only temporary
	Team leader	Only temporary
SCWMC's	9 Chairmen	Ex officio members
Chairman	initially: PD CPP	to be rearranged
Number members	between 19 and 21	

15.	Member	Elected/ Selected/ Nominated representative from the farmers's Association (representative in the District Technical Committee, Sirajganj).
16.	Member	Elected/ Selected/ Nominated representative from the Fishermen's Association (President of the fishermen cooperatives society, *Sirajganj*).
17.	Member	Elected/ Selected/ Nominated representative from the Landless Groups (Group Leader from Dip Shetu/BURO organized informal groups).
18.	Member	Elected/ Selected/ Nominated representative from the Women Cooperatives (Female Director of the TCCA, BRDB, Sirajganj Sadar Thana).
19.	Member Secretary	Executive Engineer, BWDB, CPP Division, *Sirajganj*.
And in due course:		
20.	Members	Representatives from the Sub-Compartmental Water Management Committee-SCWMCs (Chairmen) as and when formed.

Once all SCWMC's are represented the membership of the Committee may be revised.

Role of the committee:

The role of the committee could be summarized as follows:

1. To advise the Project team on policy matters regarding *Sirajganj* compartmental water management including mitigation measures for those negatively affected, both inside and outside the Compartment.
2. To enable coordination between CPP and Departments and Thanas.
3. To review progress of the CPP *Sirajganj* project and to review reports produced by the Project team and Consultants Team.
4. To advise the Project Team on project planning and implementation in the *Sirajganj* area.
5. To advise on the establishment of Sub-Compartmental Water Management Committees and to mediate conflicts between the sub-compartments.
6. To advise on establishment of the Compartmental Water Management Committee (Local Committee of Management).
7. To detail and guide the planning, implementation and review of training programmes for beneficiaries and others in connection with CPP, water management and O&M.
8. Review, supervise and implement O&M procedures at the compartment level.
9. To advise the Project Team on miscellaneous/ legal measures in respect of the *Sirajganj* water management.
10. To advise the Project Team on long-term institutional arrangements and cost-recovery options regarding construction, operation and maintenance of water management facilities in the project area.

Further details on the Compartmental Water Management Committee and Steering Committee can be found in Annex 7.

4.5.5 Training

Training is an important component of the total efforts to establish a suitable institutional framework for water management under compartmentalization. The training needs and resulting training programmes for Tangail and *Sirajganj* are similar. The *Sirajganj* programme will wherever possible build on the experiences from Tangail, and will make use, as much as possible, from trainers employed in Tangail (especially if agencies will be contracted). While negotiating contracts for Tangail, the possibility of subsequent involvement in *Sirajganj* will have to be considered. The organization of a regular exchange of ideas would be especially beneficial to *Sirajganj*. Many consultants are involved in both projects, but most of the project staff are different.

The training programme for CPP, including the choice of training methods, will have to pay explicit attention to this requirement for interactive and motivational training. The training needs assessment takes into account the innovative character of the project, as well as the fact that several techniques and approaches will have to be developed and tested by CPP itself which are not yet readily available elsewhere. Therefore CPP proposes for *Sirajganj* that the training programme should at least have the following major features:

- participatory skill training
- motivational value
- on-the job and demonstration training
- inter-agency participation
- flexibility
- replicability.

Training methods will be specific for each different course and even for separate course components. They will have to be negotiated in case a professional training institution is contracted. However, the different activities can roughly be classified as follows:

- formal training
- study tours
- on-the-job-training
- workshops and seminars
- production and distribution of audio-visual aids

The proposed training programme for *Sirajganj* is shown in Table 4.6 and elaborated in Annex 7.

The figure below presents a summary of the main items from the proposed training programme. Details will be worked out during project implementation. A tentative schedule is presented. The need for follow-up training will have to be decided in due course, and can be carried out by other organizations or consultants.

It is foreseen that on-the-job-training at field level will be important and it is proposed to appoint a special field coordinator who will be involved with the institutional and training activities at field level under supervision of the consultant institutional development and training. This field coordinator will divide his or her time between Tangail and *Sirajganj*.

Table 4.6 Summary of proposed training programme

trainees	course/ subject	location	organisation	remarks
Steering Committee/ CWMC	study tour	Indonesia	Euroconsult Indonesia	selected members, could also include non SC members: participation to be decided taking into account other training abroad such as courses in the Netherlands and Asia joint with Tangail
	workshop integrated water management	*Sirajganj*	Access	video production
	roles, functioning Steering Committee	Dhaka	BMDC	all members input consultants
		Sirajganj	to be decided	beneficiary representatives
	study tours	Comilla and other to be decided	consultants	may be joined with Tangail
project director	project management	The Netherlands	MDF	same as for Tangail
SCWMC	roles and tasks SCWMC	*Sirajganj*	CPP and specialized institution	all members
	leadership/ management	to be decided	CPP and specialized institution	chairmen
	study tours	Tangail other to be decided	CPP	selected members
WUG's	group leader ship	*Sirajganj*	BS's	selected group leaders
	water management principles	*Sirajganj*	relevant field staff	indirect
selected engineers and other staff	integrated water management and rural development	Asia	specialized institution tailor made	to be combined with Tangail and with staff from other agencies see remark SC

trainees	course/ subject	location	organisation	remarks
selected BWDB engineers	flood control and drainage	Asia	specialized institution	
	hydrology	Asia	specialized institution	
	hydraulic engineering	Asia	specialized institution	
district and thana level staff	introduction CPP, water management and institutional principles	*Sirajganj*	CPP	
field staff/block supervisors	group organization training methods	*Sirajganj*	specialized institution	
	water management	*Sirajganj*	CPP	
	on-the-job-training	*Sirajganj*	CPP	continuous in field and during regular sessions
	study tour	Tangail Bangladesh (to be decided)	CPP	can be combined with Tangail and/or other (agency) staff
NGO staff and group organisers	water management in CPP	*Sirajganj*	CPP	
operators	operational rules	*Sirajganj*	CPP	still have to be decided
LCS and EMG	technical aspects of the works contracting/ administrative procedures	*Sirajganj*	CPP field coordinator	leaders only
trainers	course preparation presentation techniques	to be decided	specialized institution	can be combined with Tangail

4.5.6 Involvement of NGO's

It is the intention that NGO's are involved in the CPP activities. However, such participation with not automatically arise. As a first and important step, another briefing for NGO's active in *Sirajganj* District, is planned to inform on about CPP's objectives and approach. This briefing aims at giving in-depth information about the CPP and the Flood Action Plan, in general.

This should certainly provide an opportunity to interested NGO's to learn about the CPP project objectives. There is much to learn and communicate and collaborate with NGO's to mutual benefit. CPP intends to build on the often greater understanding of social and economic issues present among NGO's and can benefit from the NGO's direct communication with socio-economically disadvantaged groups. The members of NGOs can take advantage of the opportunity to become involved in water management in areas of their interest. Capacity building to make this involvement effective is a responsibility that CPP and NGOs have in common.

CPP has and is producing reports about issues that are of interest to some or all of the NGOs. A number of these study reports reality available. This would help NGOs to give more substance to their participation in the envisaged Project Steering Committee (later to become the Compartmental Water Management Committee). These committees will, in the proposal, have two NGO representatives. Participation in the Steering Committee or CWMC is one issue to be discussed in CPP's briefing to the NGOs. CPP would like to see NGOs representing the various interest and experience in water management and the degree to which NGO's have a concentration on the *Sirajganj* area.

Once a CPP-NGO liaison arrangement has been established, the other operational issues can be discussed and decided. This concerns especially the following issues:
* NGO representation in Project Steering Committee;
* Involvement of NGO's in identification and organisation of LCS' and EMG's;
* Involvement of NGO's in action research on self-help initiatives on FCD;
* NGO representation in Sub-Compartmental Water Management Committees;
* Involvement of NGO staff as resource people in CPP training;
* Participation of NGO staff as trainees in CPP training;
* Participation of NGO staff in CPP activities at thana level.

Action Research on self-help initiatives

In addition to the indicated, more traditional activities, CPP hopes to acquire NGOs contribution to action research to gain more in-depth understanding of people's ability and willingness to deal with flood, drainage and water management issues. Consultations reveal one part of peoples perception of problems and solutions, but sharing knowledge, observing and learning from practice can provide valuable inputs for plans.

Action research could bring to light and build on people's motivation, experiences and practices in facing water related threats or problems, sometimes joint efforts and solve such problems. For example: they jointly construct or improve drainage canals, they

strengthen embankments, they construct bunds, they build culverts. Sometimes they solicit and obtain outside support (e.g. from Union Parishad or LGED), often they do not. There have been cases of people investing very substantial amounts of time, materials and even cash in such measures.

The level to which people take initiative is a matter of leadership, socio-economic homogeneity, the nature of the problem, accessible of expertise, and expectation of outside support.

The Compartmentalization Pilot Project is not about the GOB solving people's problems, but about the various agencies and people together doing so. Much attention is given to build on the activities of GOB agencies active in FCD, but not much to people's initiatives in this field. Therefore study of selected people's initiatives towards FCD improvement will be encouraged. A provision is made to make a limited amount available for such initiatives. These initiatives can be supported on a taka-for taka basis matching grant. Exact operational mode will be prepared, on a case by case basis.

4.6 Monitoring and evaluation

4.6.1 Outline

CPP is a complex, multi-faceted Pilot Project to be tested in Tangail and Sirajganj. As a Pilot Project it is important that all aspects are monitored and evaluated from Planning and Design to Impact Assessment. The Monitoring and Evaluation (M&E) programme for Sirajganj will be the same as that which has just been prepared for Tangail. It is not intended to establish a separate M&E unit. Instead CPP staff will carry out most of the work. To make this practical, four basic principles have therefore been adopted:

a) That all significant aspects are monitored effectively,

b) That the simplest possible approach is taken, to keep the extra work required of CPP staff to a minimum

c) That priority be given to early-warning indicators, those that will quickly show up where action to solve problems is needed

d) That all aspects will be monitored on simple standard formats which will be as easy as possible both to prepare and, for the users, to read and interpret.

Additional case studies will be called for where appropriate.

The work may be considered under three major headings:

A. Project Implementation

A.1 Project Identification, Selection and Design

Monitoring Progress in defining possible development options and identifying the preferred options.

A.2 Physical

Monitoring physical progress against project plans to ensure early action to overcome delays and other problems.

A.3 Financial

Monitoring expenditure against budget to identify both under-budgeting and over-expenditure.

B. System Establishment and Operation

Monitoring will be in two phases: system establishment and system operation. The primary monitoring objective during establishment will be to identify problems that may delay the date at which the system comes into full operation so that remedial action can be taken. During operation, the primary objective is to identify and modifications that may be necessary.

B.1 Institutional System

Establishment : Monitoring all activities involved in the creation of the institutions, Water Management Committee, Sub-Compartmental Committees etc. that make up the compartmental system.

Operation : Once established, monitoring the activities of those institutions.

B.2 Operating System

Establishment : Monitoring progress in designing the operational rules to be followed, in drawing up the necessary guidelines, in determining who is to be responsible for seeing that they are followed and in training the operators in their use.

Operation : Monitoring the operation of the physical system to measure the extent to which it is having the desired effect, in terms of flooding levels etc. Where it is not, to determine whether this is because of faults in the design or because the operating rules are not being followed. If not, why not ?

B.3 Maintenance System

Establishment : Monitoring progress in drawing up a maintenance programme, in allocating responsibilities for its implementation and in training those who have to carry it out.

Operation : Monitoring the state of repair of the system, to identify any places where it may be in need of repair, and monitoring the maintenance work done to assess, whether or not it is meeting the need. If not, was that because the programme was inadequate or because it was not being carried out ?

C. Impact Assessment

Project impact will be monitored under two headings:economic and environmental. Both will provide information on which to complete a multi-criteria analysis.

C.1 Economic

The primary aim of the economic monitoring programme will be to gather the data needed for a full financial and economic analysis of project impact. An important secondary aim will be to report on general economic trends and on any ways in which they may affect CPP.

C.2 Environmental

While the primary aim will be to provide the non-economic data for the multi-criteria analysis, this will also have the secondary aim of monitoring general trends that may affect CPP directly: groundwater levels for example.

An effective M&E system depends on regular and accurate reporting at all levels. It is, therefore, particularly important that the responsibility for reports is clearly allocated and that suitable reporting periods are chosen: not so long that the information is too old to be useful, nor so short that time is wasted on numerous "no-change to reports".

4.6.2 Monitoring

4.6.2.1 Hydrological data

The principal elements to be monitored are :

- Groundwater level
- Rainfall
- Evapotranspiration
- River stages by means of gauges program
- Land flooding stage by means of gauges program
- Changes in water demand and supply

- Erosion processes
- Sedimentation processes and possible cause
- State of structural works (embankments, structures)

In addition FAP-20 proposes that the mathematical model will be updated each year for possible changes in the set-up. Further details are given in Annex-2.

4.6.2.2 Environment

The following factors are relevant environmental key indicators.

- Fish catch and fish populations in the beels, canals and flood plains of the compartment
- Water quality (ground and surface water)
- Groundwater availability
- Fuel use for domestic purpose (changes in kind and quantity)
- Soil fertility
- Pests (insects and rats)
- Water related diseases (malaria, diarrhoeal diseases).

The indicators mentioned will be monitored, among others through the following surveys.

Groundwater Availability Monitoring

Groundwater is used for domestic water supply and irrigation. The objective of this management monitoring is to observe groundwater fluctuations over time and to develop a simple model for local groundwater recharge assessments. The model would provide flood management oriented data to identify critical levels of groundwater drawdown for various users and indicate levels which would require more floodwater entry onto floodplains to increase soil moisture replenishment and groundwater recharge.

Soil Fertility Monitoring

This management monitoring is aimed at the evaluation of physical and chemical soil properties and their changes due to CPP intervention. Special attention will be paid to soil nutrient and soil-moisture balances and the supply of nutrients during the flooding season. Soil contamination and biological imbalances due to modern agricultural technologies should be identified and mitigating measures proposed. Recommendations to maintain soil fertility under intensive cropping systems (non-flooded and flooded conditions) should be provided.

Water Quality Monitoring

This problem oriented monitoring programme aims at observing impairments which had been identified in the Environmental Pollution Survey. For example, the impact of flooding pattern and regime on the spread of communicable diseases and organic water

pollution should be analysed. The analysis can provide critieria for flushing of stagnant waterbodies or overland flow management.

4.6.2.3 Social and economic

The following socio-economic key indicators have been chosen to be monitored during the project life cycle :

- Distribution of temporary income
- Distribution of structural benefits
- Employment opportunities as expressed in the wage rate
- Cropping pattern changes
- Yields of corps
- Crop damage
- Cropping intensity
- Farmgate prices of crops
- Market Prices of Agricultural Inputs & products.

4.6.2.4 Institutional

Compartmentalization Pilot Project is testing a new approach to flood control and drainage that emphasises peoples participation. Institutions are, therefore, central to the projects. Monitoring progress in this area will be given particular attention. The effectiveness of the institutional arrangements will be monitored using the following indicators :

- Functioning Compartmental Water Management Committee
- Functioning of the Sub-Compartmental Water Management Committees
- Conflicts between people living inside and outside the compartment
- Inter-Sub-compartmental conflicts
- Illegal interventions
- Functioning of Landless Contracting Societies, Embankment channel and Structure maintenance groups
- Effectiveness of the rules for functioning the organizations at different level
- Progress towards sustainability, both financial and social.

4.6.2.5 Training

The following indicators will be monitored:

- Training course organized
- Numbers attending
- Participation in the Training courses by Target groups.

Specific arrangements will be made to test the value of the courses by post-training interview and, where appropriate, testing.

4.6.3 Impact assessment and evaluation

A Household Survey of Sirajganj Project Area, Adjacent Areas and a Control Area is currently underway and this will provide a baseline for impact assessment and evaluation. A post project survey will be carried out for comparison with the baseline.

It is not, however, intended to rely solely on the Baseline/Post-Project Survey Approach. A straight comparison between two surveys can be misleading. When, for example, harvests are particularly good (or bad) in one of the survey years.

For this reason an Agricultural Monitoring survey is planned to record changes in cropping patterns and production annually. Through this it will be possible to distinguish between year to year variations, long term trends and the effects of the project.

The project effect on income and income distribution are, of course, of first importance. It must be recognized however that both in small holder farming and among the landless, who have complex income earning strategies, it can be extremely difficult to gain a true measure of income. Particular attention will be paid to finding the best approach to this problem.

The final evaluation will be in three parts :

Economic	:	Using standard cost benefit techniques backed up by analysis of changes in farming systems, fishery systems and employment.
Environmental	:	Covering ecological effects, wildlife, vegetation and in particular, soil and water quality.
Institutional	:	With an emphasis on the sustainability of the institutions sponsored by the CPP.

4.7 Special studies

4.7.1 Agricultural studies

Proposed studies will be executed in consultation, cooperation and active collaboration with related departments.

a) Production system analysis (PSA)

MPO (1986) provides a comprehensive production system analyses for regions of Bangladesh. With the gradual development of water market, release of sale and distribution of irrigation equipment, fertilizer etc. to private sector and development of demand-driven input prices, a reanalyses of production system is needed. Farmer, with his number of limitations and resources constraints, operates his land in a way to derive

maximum benefit i.e. he has his own production system on farm level. His knowledge, economic vulnerability, available opportunities etc. determines his farm operation. The main objective of PSA is a good understanding of the farmer's way to cope with the risks and benefit of the floods for better understanding of the bottlenecks. Impacts of improved water management on the total production system will be identified i.e. ..., *"monitoring the results of water control operations, with particular attention to agricultural activities..."* [ToR, page 13). More acceptable and realistic production system alternatives will be constructed.

b) Study on opportunities for livestock and poultry

Increased production target in the compartment demand additional draft animal available in the area. Farm mechanisation is an alternative but yet to gain popularity within the scope of production cost. Possible impact of improved water management on livestock & poultry is not defined. This study will define specific opportunities for livestock and poultry development activities in the area. It is assumed that with flood control and drainage systems development the livestock will have a fair scope to develop in well drained catchment for grazing, forage crops development in the cropping pattern and additional feed availability from the by-products and residues of intensive crop productions. Similarly poultry will also be developed. This opportunity might largely contribute to the protein needs of the area and would supplement to a fair extent to the negative impact of fisheries. A specific development plan for the CPP area is expected.

4.7.2 Fisheries

In order to guide fisheries development and evaluate in the future the impact of a stable BRE and the compartmentalization, more detailed base line information will be needed on Fishing effort, fish stocks, recruitment and migration patterns etc. Data obtained from the Special Fisheries Study of the CPP project in Tangail and data from FAP 17 will be used at first. Where complementary data are needed (construction of artificial duars, Beel sanctuaries, etc), the Special Fisheries Study will execute special survey's in close cooperation with the Fisheries Department of Sirajganj.

4.7.3 Socio-economic studies

To produce relevant and effective policies and guidelines for future compartmentalization, knowledge about the socio-economic situation of all affected categories of people is of great importance. Aspects as people's participation, mitigation measures for those who are or may become disadvantaged through project and water management as such, require more information than available now. In the study plan the following issues might be included.

a) Labour market

One of the aims of the CPP is to direct as many structural benefits of compartmentalization as possible to the disadvantaged. To do so the major mechanisms (locality and season related) that together determine the demand and supply of labour must be understood.

The (local) mechanisms behind supply and demand for labour will be studied. This will build on a similar study done in Tangail CPP and will concentrate on in-depth interviews. If possible a link will be made to the wage level monitoring so as to correlate and verify the data and information gathered.

b) **Local water management committees in the Sirajganj CPP area**

The institutionalization of water management, from the local to the national level, is also a task of FAP 26. However, the set-up of the local institutions and the process of decision making can not be separated from the total water management structure. There are existing institutional arrangements at all levels. It is likely that the CPP will advise on setting up new or renewed institutional arrangements, starting at the local level.

There are sluicegates, irrigation equipment etc. that often have management committees of one kind or another. It is necessary to know more about these committees and prevailing institutional arrangements.

4.7.4 Environmental Studies and Initiatives

a) *Studies*

Special studies are aimed at obtaining data on environmental elements and to provide information required for the Environmental Management Plan. They are tailor-made and concentrate on important issues which were identified during the process of scoping as sensitive environmental resources and which are already impaired or at increased risk in the CPP area.

Five special studies are proposed covering ecological and wetland conservation issues, environmental pollution, development of agroforestry resources, and public health issues. Details are given in Annex 6, Chapter 8 and in a Technical Note: Environmental Surveys and Initiatives.

Ecology

The objective is to conduct an inventory of selected terrestrial and aquatic ecological zones which are under continuous stress from human interventions: lowland zones, floodplain proper and highland habitats. Surveys during the wet and dry seasons should provide information on ecosystem's status and regional importance and the presence and status of threatened or endangered fauna and flora species. An environmental management plan should be drafted to conserve such species at key sites.

Homestead and Embankment Plantation

Homestead and embankment sites provide the highest potential in terms of floral and faunal diversity but they are often underutilized. Plantations are likely to benefit from CPP works, as other terrestrial habitats. The objective is to identify key areas for rural

homestead plantations and embankments suitable for plantations. Models of improved agroforestry and social forestry should be developed and an outline of planning, design and implementation presented, including institutional and tenurial arrangements. Women in Development aspects should be addressed especially in relation to the increase of production of common goods for multipurpose uses such as fuel, fodder, food, medicinal plants and timber.

Environmental Pollution

The objective is to identify types and sources of urnban and rural pollution in soil and water resources. Special attention will be given to agrochemical, urban industrial and cottage industry and human-faecal pollution sources and the fate of potentially harmful substances.

Wetland Conservation

The conservation of permanent swamps (beels) is of national concern. Key areas with a high potential for migratory and resident wildlife should be identified and developed for mitigating adverse impacts by existing and new FCD works. Conservation inititives and measures should be proposed aiming at multiple beel uses (fisheries, waterfowl and wildlife, aquatic flora). Proposals for implementation should be based on a community based development. Privately owned key beels could be purchased by the responsible GOB institution and leased to such communities.

Urban Health

The survey is aimed at identification of major hazards and risks related to polluted water and unplanned waste disposals in the Sirajganj town. CPP works should aim to minimize risks associated with polluted surface and groundwater. There is potential to use river flushing as a means of control. The survey should identify appropriate and safe measures and assist in formulating associated programmes to improve the urban water-related health situation.

b) *Environmental Monitoring Surveys*

Problem monitoring aims to get information on the extent to which potentially harmfull substances are in water and soil resources and to which extent the CPP influences such pollutions. The major goal is to test on suspecions whether significant problems exist or will develop and - if so - to develop inititiatives for mitigation within the scope of CPP works. Management monitoring addresses long-term environmental management, It determines the extent of deterioration of natural resources, eg. soil fertility or groundwater availability, and indicates if immediate actions would be required to maintain sustainable resource uses (See also Section 4.6.2.2).

c) *Environmental Mititgation and Enhancement Initiatives*

Based on the identification of likely impacts as a result of CPP and previous FCD activities, there are proposals of minimising or avoiding those that are negative. In addition, initiatives are proposed to enhance such environmental elements which are currently underutilized. At this planning stage, only key elements of future environmental management initiatives can be outlined:

- mitigating further wetland losses by developing a community based "wetland conservation programme"
- mitigating further increases of pesticide uses by initiating an "integrated pest management" programme
- enhancing rural homestead plantations by promoting fast growing multipurpose tree species; an agroforestry programme should be initiated on key sites.
- enhancing underutilized embankment plantations by promoting a "social forestry programme" on road and river embankments.
- urban health promotion programme which is aimed at improving health conditions in Sirajganj town related to river water pollution. The programme is focused at reducing toxic industrial pollution and improving sanitation measures to reduce human-induced organic pollution of the Baral River.

d) *Initiatives on Environmental Awareness and Education*

A programme in nonformal environmental eduction should be initiated at the village level. An important outcome would be to support values and motivions conducive to behaviour patterns and measures that are instrumental in preserving and improving the floodplain environment. Subjects relevant within the context of the CPP are proposed in Annex 6, Chapter 8. Target groups could be water user groups of the CPP area and other affected individuals or local NGO's.

4.7.5 Transport and Marketing

Agricultural marketing in the project area is dominated by the private sector, with only little interference from the public sector. The latter refers almost exclusively to the provision of the national food reserve (paddy) through licensed dealers, guaranteeing of a minimal producer price mainly for cereals and observation of the market by District Marketing Officers.

The flow of agricultural produce from primary markets in the interior towards higher structured secondary markets in urban centers for further handling and distribution is organised by a system of middlemen. Some of the more influential, higher ranked among them are certainly in a postion to impose monopolistic conditions on local markets, at least temporarily. The price farmers get for their produce varies from region to region

based on local conditions. The difference, for instance, for aman paddy is known to be about 3 to 4 % (about 30 Tk/100 Kg) between surplus and deficit areas.

Transport accessibility to local markets is not always easy, as some may only be reached at times by traditional means like oxen carts and rickshaws, due to poorly maintained roads. Some of these roads are actually embankments. Most of the markets may therefore not be served by average sized trucks. Water transport is obviously very important, to which extent, however, has till to be investigated in much more detail, including possible interference with project activities.

Major problems related to local marketing conditions are related to physical infrastructure (evacuation of produce from the "interior"), rising transport costs, market tolls and lack of storage facilities.

In order to assure a sound impact analysis in the future, the information collected so far must be verified and expanded. In general, major constraints in marketing and input supply demanding clarification may be recapitulated as follows:

* The household survey and the sub-compartmental survey should be fully processed and data presented in a statistically usable form.

* Restricted availability of fertilizers in quantity and quality during peak season of demand. As to the efficiency of fertilizer, clarification as to types and quantities used in which crops would facilitate conclusions which will be closer to reality.

* Higher prices for fertilizer during peak demand periods, especially in regions with imperfect marketing conditions.

* Transport accessibility to local markets is severely restricted due to missing or poorly maintained rural roads. The resulting effect may be essential to further development and should therefore be investigated more carefully.

A thorough investigation of above constraints and their close evaluation will be indispenseable if impact on farm level attributable to improved watermanagement by compartementalization is to be assessed in end-term evaluation. The corresponding objective is therefore to eliminate distortions as described above in addition to those caused by changing share-cropping patterns or political decisions which could substantially change cultivation practices. With current plans of the Government to withdraw subsidies on fertilizers, the intensity of fertilizer may be reduced. The corresponding outcome will be declining profitabilty levels, especially for small and landless farmers, who traditionally suffer from lack of funds. Those influences are, understandably, not to be attributed to compartementalization.

In summarizing above recommendations it is obvious that they are, in line with the aim of economic evaluation, centered around the interest to get reliable information for all impact assessments to come.

5 COST ESTIMATES AND IMPLEMENTATION SCHEDULE

5.1 General

The philosophy of the compartmentalization project can be realized through the implementation of both structural and non-structural measures (Chapter 3).

In the ToR the following is stated about the relationship between structural and non-structural interventions:

> *"Detailed design and construction of works will follow ... It will be important to maintain a flexible approach and programme, linked to the non-structural activities"* [ToR, p. 8.9].

The basic assumptions behind making the implementation of physical works dependent on the non-structural activities are:

- fixed structural works, such as re-excavated *khals* and un-gated structures, only yield their expected benefits if the required non-structural pre-conditions such as institutionalization, credit, training, seeds supply etc. are available,
- operable structures, such as gated regulators, will furthermore only yield their optimal and sustainable benefits if operation takes into account the affected interest groups organized through WUG's,
- as gated structures are vulnerable to misuse, interest groups must firmly be established before balanced operation can be expected.

For these reasons it is proposed that the committees are in place and functional before the new structures are operated.

5.2 Groups of Structural Elements

The following groups of structural elements have been identified.

I) EMBANKMENTS/ROADS (EXCEPT BRE)

All the embankments on the periphery of CPP SIRAJGANJ can be included in this set of measures. Its main function is to protect the area from major floods originating from outside the CPP Sirajganj area. In OPTION 2A and OPTION 2B the proposed emabankment actually encompasses a continuous embankment which includes the entire Northern and Western side of the compartment.

II) REGULATORS/BRIDGES

These structures have as main function to regulate water
*) from outside the compartment (as peripheral); or
*) from a neighbouring SC

to
*) a neighbouring SC; or
*) the drainage system.

III) IMPROVING EXISTING REGULATORS

Some of the existing regulators need an improvement or adjustment based on changed circumstances, for its anticipated use or to rectify faulty design.

IV) DRAINAGE CHANNEL EXCAVATION

Drainage channel excavation forms an important part of the improvement on the drainage system. The most important channels which in the existing drainage system need to be re-excavated.

V) EROSION PROTECTION

The breach mitigation measures (embankments/roads) are to be accompanied by erosion protection measures, especially adjacent to the major structures in the breach mitigation embankments due to the high risk of excessive erosion as a result of anticipated high waterlevels and/or high flow velocities.

VI) FIELDLEVEL WATERMANAGEMENT

Field level watermanagement forms the backbone of an integrated water manangement system which can considerably improve the water use efficiency. Microlevel changes at fieldlevel can make watermanagement more effective. It is proposed that in all SC's this microlevel improvement is to be performed.

VII) MITIGATION MEASURES

The impact of the CPP Sirajganj project activities on the surrounding area (and within the area) can be negative. The most obvious places for mitigation measures are those areas where the impact of the *Ichamati* embankment is felt. Therefore, a special set of mitigation measures are proposed to counterbalance these negative effects.

VIII) *Brahmaputra* RETIRED EMBANKMENT

Based on historical data it is estimated that on the average, every year a certain stretch of the BRE needs to be retired. In a number of consecutive years, this can be even the same location which suffers a breach previously.

IX) SIRAJGANJ TOWN DEVELOPMENT

Sirajganj town is part of the compartment and due to its urban population and needs, it is proposed to treat Sirajganj town as a separate unit. Main activity will be allow *Jamuna* river water to enter the open sewage option in order to flush the channels. Furthermore additional bridges are proposed to be build.

Table 5.1: Cost estimates for various option specified per groups (Lakh Taka)

	OPTION 1	OPTION 2A	OPTION 2B
I	149.8	395.2	536.1
II	690	890.0	890.0
III	10.0	10.0	10.0
IV	256.4	256.4	256.4
V	115.0	115.0	115.0
VI	400	400.0	400.0
VII	71.0	71.0	71.0
VIII	40.0	40.0	40.0
IX	186.0	186.0	186.0
	1978.2	2363.6	2504.5

5.3 Costing of structural elements

The estimate on total construction cost is based on Schedule of Rates for Compartmentalization Pilot Project, BWDB, Tangail effective from 1-9-1992.

For a number of items a unit cost price approach is maintained while for a number of items a lump sum approach is used.

The total set of possible structural elements have been divided into Groups. Each Group is a functional unit whereby all structures with similar purposes are put together. The only exception is Group IX which encompasses Sirajganj Town Development.

Group I is formed by items including Embankments/Roads. The total volume for this group is estimated on a M^3 basis. For the Ichamuti embankment scenarios a detailed survey has been performed while for other SCs boundaries and roads, an estimate has been made based on topographical maps.

The Group II (Regulators/Bridges) and Group III (Improving Existing Regulators) cost estimate is based on a lumpsum approach only.

Group IV (Drainage Channel Excavation) cost estimate is based on detailed topographical survey.

Group V (Erosion Protection), Group VI (Fieldlevel Watermanagement), Group VII (Mitigation Measures) Group VIII (*Brahmaputra* Retired Embankment) and Group IX (Sirajganj Town Protection) are in principle all based on lumpsum approaches.

The costs for all the three options are summarized in Table 5.1.

5.4 Implementation of Non-Structural Interventions

The main non-structural interventions are;

- establishing the Compartmentalization Pilot Project Steering Committee
- facilitating GOB interdepartmental cooperation
- training programme
- consultation process
- establishing and facilitating Water Users Groups
- establishing and facilitating Landless Contracting societies
- establishing and facilitating Sub-Compartmental Water Management Committees
- establishing and facilitating Embankment, Channel and Structures Maintenance Groups

The CPPSC is to be established by November 1993. From mid 1994 onwards the CPPSC is to be expanded with representatives from the SCWMC. This process will continue until mid 1995. By that time the CPPSC should be transformed into the Sirajganj Compartment Water Management Committee. For more details see Annex 7.

The training programme is to start by September 1993. It will peak during the first year after that and then continue at a lower level for another 2 years. For more details see Annex 7.

The activities related to water management inside the compartment (from the consultation process to establishing Embankment Maintenance Groups) are phased in such a way that they precede the planned structural interventions (see previous section). The following overall implementation schedule is planned;

- Oct 1993-May 1994; Sub-compartments 1, 2, 3 and NE and NW adjacent areas
- Oct 1994-Feb 1995; Sub-compartments 4, 5, 6, 7, 8, 9 and the Western adjacent area

The following detailed plan is proposed to complete the consultation process. It may be noted that, before writting the SIR, one first phase consultation meeting was held in each sub-compartment for each interest group. As this does not provide sufficient coverage to facilitate futhure institutionalization, one more meeting per sub-compartment and per interest group is now planned to complete the first phase of consultation meetings.

Sub-Compartments 1-3, N and NW adjacent area

1st Oct - 25 Nov. 1993	:	Second half of first phase (with Sub-Compartmental Development Plan) consultation meetings with separate Interest Groups
25th Nov. - 15 Dec. 1993	:	Combined meetings with contact persons including elected Representatives, local Elites and village Matabbars.
20th Dec. - 15 Feb, 1994	:	Second phase of separate Interest Group meetings
10th Feb. - 15th Mar, 1994	:	Combined meetings with contact persons including elected Representatives, local Elites and village Matabbars.

Sub-Compartments 4 - 9, & Western adjacent area

21st Mar. - 31 May 1994	:	Second half of the first phase consultation meetings with separate Interest Groups.
June 1994	:	Combined meetings with contact persons including elected Representatives, local Elites and village Matbars.
September- December 1994	:	Second phase of separate Interest Group meetings
January 1995	:	Combined meeting with contact persons and elected Representatives

The above schedule has been made to fit in with the proposed construction schedule. As such it does not delay the construction, but runs parallel. This schedule leaves time for the necessary feedback to the planners so that plans can be adjusted in the light of the findings during the consultation process. If few conflicts of interest exist in an area, then the second phase of separate meetings may be shortened.

Within this overall framework the consultation process will be the starting point for the non-structural interventions in the Sub-Compartments. It will be followed by the establishment of WUGs and SCWMCs.

In October 1993 a start will be made with establishing LCSs. EMG will be formed as and when embankments are completed and maintenance can be taken up.

5.5 Costing of non-structural interventions

The cost estimate of the non-structural interventions has been calculated based on the experience gained from CPP-Tangail to date.

	1993/94	1994/95	Total Lakh Tk
1 Consultation process	3	2	5
2 Establishing CPP/SC and SCWMC	2	1	3
3 Establishing WUGs	15	8	23
4 Establishing SCWMCs	1	3	4
5 Facilitating LCSs and EMGs	2	2	4
6 Publicity and information	2	1	3
7 Seminars, courses, workshops	3	4	7
8 Training in Bangladesh	4	5	9
9 Training outside Bangladesh (Except Netherlands)	15	16	31
10 Training in The Netherlands	6		6
Total	*53*	*42*	*95*

5.6 Implementation Schedule

The work planning of structural and non-structural interventions have been merged in such a way that a fine-tuned match is found between these components.

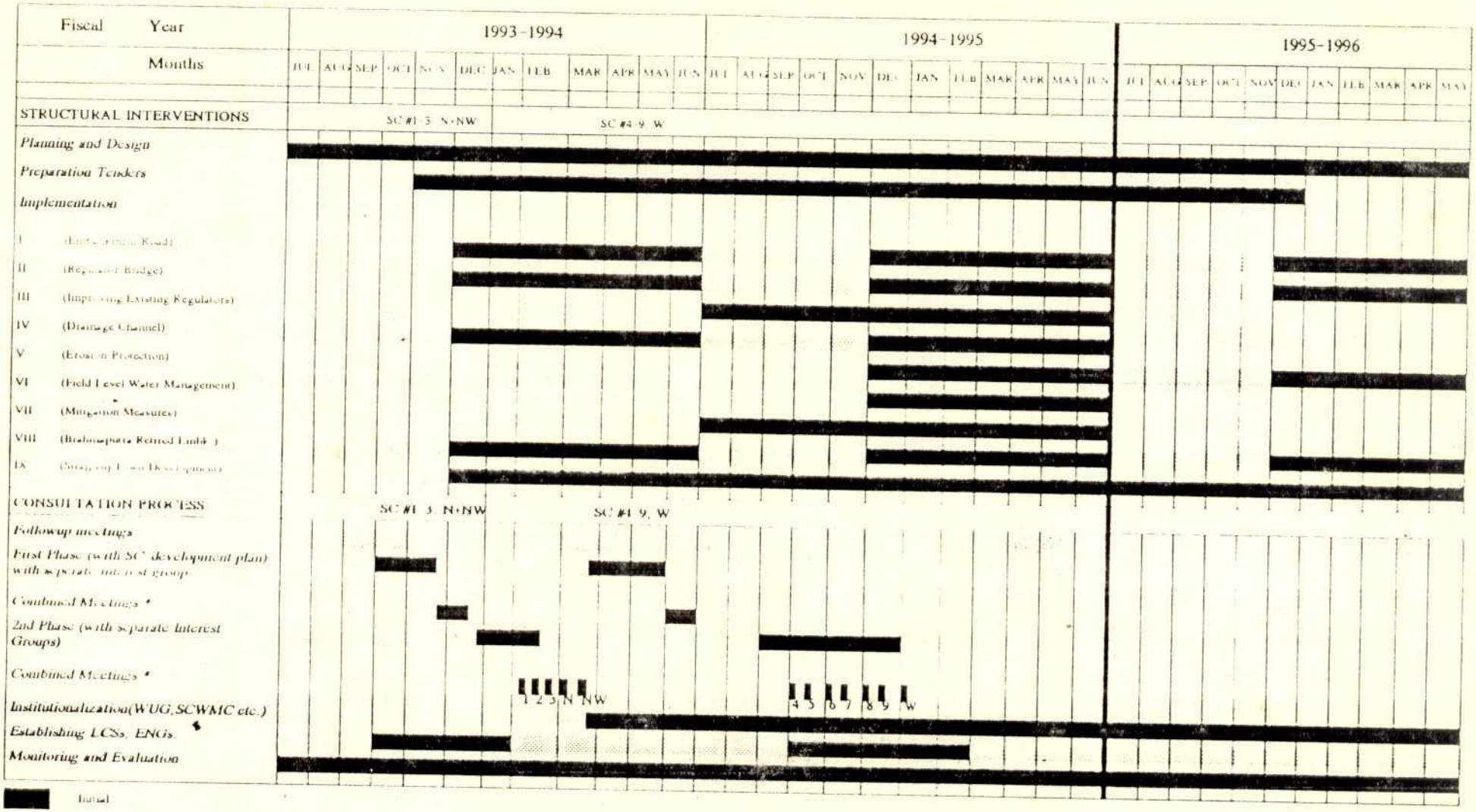
The main points from the proposed work planning Figure 5.1.

*) The consultation process in all its phases preceeds any structural intervention.

*) The priority is given to consultation and a direct follow up by implementation of structural elements in the SC 1,2 and 3 for the first year. This allows sufficient time for the consulation proces to be performed in all the other SC's in the second (1994/1995) year.

*) The priority is based on the assumption that although the BRE is sealed, there is still a chance that a breach may occur under exceptional circumstances. Therefore, the protection of the compartment should receive first priority in case a breach occurs.

FIGURE 5.1 : GENERAL IMPLEMENTATION SCHEDULE OF CPP SIRAJGANJ : 1993–1995 (1996)



* Including contact persons, elected representatives, local elites, village matabbars etc.

Figure 5.1: General implementation schedule of CPP Sirajganj : 1993-1996

6 ASSESSMENT OF IMPACTS

6.1 General

The impact assessment has followed the Guideline for the Project Assessment (FPCO, 1992). Recent versions of certain Annexure of this GPA was also considered. The project is so designed to achieve the overall objective of compartmentalization as envisaged in the ToR.

> *"The overall objective is to provide, through water management, a more secure environment for intensive agriculture, fisheries and integrated rural/urban development, and thereby improve the economic security and quality of life of the floodplain population"* [ToR. p.3].

The main impact of compartmentalization is achieved on changes is hydrological situation with associated field water levels. These changes is translated into impacts on agriculture and fisheries. Impact in these two important production sectors will bring about socio-economic changes on target groups of the CPP such as farmer, fishermen, landless, women and urban dwellers. The impact on hydrology, agriculture, fisheries etc. will create an impact on the environmental parameters. These environmental parameters are assessed in the backdrop of Environmental Policy recently adopted by the Government of Bangladesh.

The economic analysis consider the impacts on agriculture and fisheries, a range of development trends, contribution from mitigation measures, indirect benefits etc. in without project situations compared to different options in with project situations. These quantitative assessment were measured again with qualitative scores for a number of social, institutional and environmental indicators. There are all assessed in a comprehensive multi-criteria analysis. The main purpose of this analysis is to highlight contrasts between the options developed that is Options 1, 2A and 2B. The analysis shows the differences adequately for most components. However, it does not represent the assessment of the final status either of mitigation or of enhancement measures proposed. At this stage, importance has been given to arrive at a sustainable stratgegic approach i.e. to establish and operate the compartment and to test the concept of compartmentalization.

6.2 Hydrology and water levels

6.2.1 Impact on the CPP area

The impact of different options in diffrent Sub-Comaprtment is assessed using the mathematical models. The internal impact is assessed by comparing 'without' and 'with' project situation. The impact is described in terms of water level variation under the two mentioned situation. In 'with project' situation different options, as described before, Opion 1, 2A and 2B are considered. The fundamental difference between OPTION1 and OPTION 2A, OPTION 2B is the Ichamati river side embankment and difference between OPTION 2A and OPTION 2B is the alignment of the Ichamati river embankment.

In order to facilitate the model results interpretation, the sub-compartment are classified in to two categories i.e Sub-Comaprtments directly influenced by the Ichamati river (SC2, SC4, SC6 and SC8) and Sub-Compartments near the BRE (SC1, SC3, SC5 and SC7).

Basic Assumptions

The assumptions made duroing the analysis in diffrent options are as follows:

* All the river/channels in the project are taken in the study.
* 1 in 5 year water level is used.
* rainfall-runoff is included in the analysis.
* In 'with project' situation, drainage improvement is considered.
* Area - Elevation for the comapartment is based on 1964 contour maps.

Without Project

The without project situation is the existing situation. The flooding in the project area is characterised by the Ichamati river flooding, rainfall-runoff generated in the upper catchment conveyed by Ichamati (khal and branch) and BRE breach flooding. In this situation, along BRE, no structure is assumed working properly i.e. zero flow from from Jamuna is taken.

OPTION 1

The difference between 'without proeject' and OPTION 1 is that along BRE, four inlet structures, improved draiange and one diversion structure in Ichamati branch are considered. As a consequence, in OPTION 1, the water levels in SC2, SC4, SC6 and SC8 are similar to without project situation. In SC1, SC3, SC5 and SC7, the water level will be slightly diffrent than the without project situation and it is due to presence of three BRE inlet regulators. project situation.

OPTION 2A

The main difference in this option with OPTION 1 is the embankment along the Ichamati river and control structures in every entry point from the Ichamati river. The BRE structures and drainage improvement remains the same as outlined in OPTION 1. In OPTION 2A, the Ichamati side embankment follows a existing road (see SECTION). Due to this embankment alignment, partial area of the sub-compartments SC4, SC6 and SC8 fall outside the embankment (Table 6.1). The outside area is influnced by the Ichamti river. The SC1, SC2, SC3, SC5, SC7 are similar to the withproject, option 2B situation.

Table 6.1 Affected sub-compartment area and water level in OPTION 2A

Affected Sub-Compartment	Gross Area (ha.)			Water levels (1 in 5 Year) in +M. PWD	
	Total	Internal	External	Internal	External
4	1371	1122	249	13.02	13.47
6	1455	1331	124	12.43	13.06
8	2319	1551	768	12.33	12.70

The total outside area is 1141 ha. If this option is compared with OPTION 2B, in 2B, the increase in F0 land is about 403 ha. (SC4 222 ha. SC6 11 ha, SC8 170 ha.).

OPTION 2B

The main difference between this option with OPTION 2A is the embankemnt alignment i.e the alignment follows the Ichamati river bank. The area fall outside in OPTION 2A are included in this option. The peripheral structures and BRE inlet structures remain the same. In SC1, influence of the proposed structure is observed. During the peak time, the water level difference between Without and With project is around a metre. The flow is diverted through the Ichamati Khal. In SC2, upto July, the with project water level is higher than the without project situation. It is due to the retention structure proposed at the downstream of the Ichamati Branch. At begining of the August, the gate of the retention structures is opened (as long as head is available to drain) and it starts draining. In SC3, due to presence of BRE strucure, the with project premonsoon levels remain slightly higher, then the without project situation. After the first peak (pre-monsoon) passes, the gates are closed and the its influnce is observed. In SC4 and SC6, the area is influnced by the Ichamati river. Drainage largly depends on the head availability between Ichamati river and the inside water level. SC5 and SC7 is drained through mainly by the Baniajan river. In SC7, draining is limited during the monsoon. In SC8, a similar behaviour is observed. This is due to the 'backwater' or 'backflow' in Ichamati river.

The summery of water levels of the three options are given in the Table 6.2.

Table 6.2 Summery of water levels in different options of 'with project' situation

Sub-Compartment	1 in 5 Year water level (M PWD)		
	Base	OPTION 1	OPTION 2A and 2B
1	12.31	12.44	12.44
2	13.43	13.43	12.44
3	12.96	12.43	12.43
4	13.38	13.38	13.02
5	12.98	12.43	12.43
6	12.98	12.98	12.43
7	12.44	12.30	12.30
8	12.43	12.43	12.33
9	12.40	12.30	12.30

Source: Annex 7, Mathematical Modelling, Sirajgani Interim Report

6.2.2 Impact on the Adjacent Areas

The future with project situation has definite impact on the adjacent areas (external) in terms of water level. This is due to mainly structural intervention in the floodplain channel and embankment placement along Ichamati river. As mentioned earlier in the option developemnt that, proposed structures will regulate floodplain channel and the embankment will protect area behind it from flooding from the Ichamati river. The rise in waterlevel is calculated when all the peripheral structures are closed. The event taken for

analysis is 1 in 5 year and a BRE breach situation. The BRE breach took place near *Kazipur (Junkail)* in 1991. The impact areas are categorised into three groups i.e.

* maximum affected areas
* moderately affected areas
* minor affected areas

The northern areas (north of *Ichamati* khal) fall in the first category. In this area, the maximum rise in water level upstream of the Ichamati branch structure (near *Ratankandi*) is around 0.30 - 0.40 m (1 in 5 year situation). This is mainly due to the *Ichamati* branch flow diversion into the *Ichamati* khal.

For impact assesment, *Ichamati* river is divided in to two areas. From the confluence of Ichamati Branch and *Ichamati* river upto *Garudah* belongs to the second category. In OPTION 2B, the water level could rise upto 0.20 m - 0.30 m.

In the *Ichamati* river, from *Garudaha* to *Bhadraghat*, the impact of project interventions is less. This is due to the 'backwater' or 'backflow' in the *Ichamati* river. *Ichamati* river water is backed up by the *Hurasagar* system. However, the maximum possible rise due to project interventions is between 0.10 m - 0.18 m.

6.3 Agricultural impacts

6.3.1 Assumptions in impact assessment

The general assumption is that future improvements in agricultural production will result from a number of factors including increase in cropping intensity, higher production levels, better farming methods, higher resource investment in a secured crop environment and the use of improved varieties. Some of the basic assumptions are:

a) The with project situations and its options assumes the BRE to provide protection to a certain level.
b) Net cultivable area will not increase rather decrease due to expansion of settlement area. As the effects will equally be on situations of with and without project, no adjustment has been made.
c) Land types in all situation are based on Mike11 computed 1:5 year return period water level and on digitized contour levels of 1964 map. Potential errors are known but it is assumed any error will affect the options equally.
d) A moderate increase in irrigated area is assumed through the intensive use of STW rather than DTW.
e) A substantial portion of the NCA is under sugarcane. It is assumed that area under sugarcane will increase moderately because of a proposed setting up of a Sugar Mill in *Belkuchi*, adjacent to the project area.
f) The increases in yield will be modest and remain within the achievable potentials identified. This yield increase assumes higher input use and investment in an improved water management practices and institutionalized participation of farmers, extension agents of the DAE, credit organization in project activities to promote

agriculture of the area. The improved water management systems operated through field level, sub-compartmental and compartmental structural interventions will initiate activities needed for increase in per unit area crop yield. It is assumed that more and more HYVs will replace local varieties for all crops.

6.3.2 Impact on land types

The different project options provide for control mechanism for in and out flow of water at levels of compartment and sub-compartments. These control mechanisms change the water level differently at different points of the compartment. The changed water levels of 1:5 year return period dictates the classification of land types (Table 6.3).

Table 6.3: Changes on land types under different project options of the CPP, Sirajganj

Land types	Base		With Project					
	Area	% of NCA	Option 1		Option 2A		Option 2B	
			Area	% of NCA	Area	% of NCA	Area	% of NCA
F0 Total	2913	31	4380	45	5121	53	5524	57
Dry	1322		2722		3496		3788	
Flooded to 30cm	1591		1658		1625		1736	
F1	3681	38	2936	31	2642	28	2846	30
F2	2715	28	2005	21	1602	17	1124	12
F3	270	3	258	3	214	2	85	1
Settlement	2212		2212		2212		2212	
Waterbodies	266		266		266		266	
Gross area	12057		12057		12057		12057	

Source: CPP computation based on 1:5 water level NCA = 9579 ha.

There will be substantial increase in F0 land types in with project situation. This will change from 31% in the base situations to a range of 45-57% under different options in with project situation.

6.3.3 Impact on crops and crop production

Future Cropping Pattern: Future cropping pattern will essentially remain the same as it is practiced now with certain modification. Single crop pattern will be replaced by double crop pattern.

It is the reclassification of lands into new type such as F_1 lands turned into F_0 will ensure higher crop coverage and crop production. Triple crop pattern will be introduced even on F_0 land type. Future cropping pattern on different land types are shown in Table 6.4.

Table 6.4: Future cropping patterns (options 2A & 2B)* on different land types in the CPP, Sirajganj

Land type	Cropping Patterns
F_0	Boro (HYV) - T. Aman (HYV) Boro (HYV) - T. Aman (HYV) - Mustard Wheat - Jute Sugarcane + inter crops Boro (HYV)-T.Aman(HYV)-Others T. Aman (HYV) - Jute T. Aman (HYV) - Winter Vegetables Wheat - Jute - T.Aman (HYV) Others
F_1	Boro (HYV) - T. Aman (HYV) - Mustard Wheat - Jute - T. Aman (HYV) Jute - T. Aman (HYV) - Pulses Jute - T. Aman (HYV) - Others Boro (HYV) - T. Aman (HYV) Boro (HYV) - T. Aman (Local) Boro (HYV) - Mustard Boro (HYV) - Others Wheat - Jute Sugarcane + inter crops T.Aman (HYV)-Jute T.Aman (HYV)-Winter Veg. Boro(HYV)-T.Aman(HYV)-Others Others
F_2	Boro (HYV) - T. Aman (Local) Boro (HYV) - Mustard
F_3	Boro (HYV) - Mustard Boro (HYV) *In option 1, pattern using B.Aus will also be used

Crop yield: Prediction of crop yield in with project situation is the most sensitive factor in the estimation of the agricultural impacts. Study of future trends in crop yields is particularly complicated because it is necessary to assess the progress of new varieties, changes in input use, climate influence and other factors.

Estimation of yields for different crops grown in the area is shown in Table 6.5. Base situation yield is from a landuse survey. Without project yield accomodates a nine-year trend of Sirajganj Sadar Thana which is in the range of 0-3.8% for different crops. In estimating with project yield, a consideration is given on regional yield estimates and projections such as FAP 2. With project yield assumes implementation of structural interventions such as compartment development with control structures and field level water management and non-structural interventions such as active DAE participation and institutionalization of Water Users Groups (WUGs).

Table 6.5: Yield (t/ha) of crops grown in the CPP area, Sirajganj

Crops	Sirajganj Thana		Regional (FAP 2)		CPP Projections				
	Damage free	Damaged	Present	Future	Base Situation		Without Project		With Project (all options)
					Damage free	Damaged	Damage free	Damaged	Damage free
Rice									
B. Aus	1.75	0.61	1.60	1.68	1.28	0.79	1.32	0.81	1.32
T.Aman (Local)	1.55	0.32	2.25	3.26	1.35	0.40	1.38	0.41	1.97
T.Aman (HYV)	3.67	0.45	3.75	4.31	3.17	1.00	3.27	1.03	3.79
Boro-(HYV)	4.10	-	4.50	5.18	4.41	4.00	4.58	4.15	4.73
Wheat	1.87	-	1.70	1.79	2.44	2.00	2.47	2.02	2.87
Jute	1.53	1.00	1.70	1.79	1.43	0.98	1.43	0.98	1.78
Sugarcane	42.54	-	42.00	44.10	50.20	47.54	50.20	48.40	52.18
Pulses	NA	NA	0.80	0.84	1.03	-	1.05	-	1.12
Potato	8.72	-	10.00	10.50	9.79	-	9.97	-	10.68
Mustard	0.70	-	0.70	0.74	0.79	-	0.79	-	0.85
Spices	NA	NA	NA	NA	1.31	-	1.35	-	1.75
Vegetables + others	NA	NA	NA	NA	4.76	-	4.90	-	5.04

Sources:
- Thana = DAE, Sirajganj Sadar Thana, average of 9 years between 1983-84 to 1991-92
- Regional = FAP-2 Estimates
- Base = Landuse Survey, CPP, January-April 1993
- Without Project = Estimation based on trend with yield increase in the range of 0-3.8%
- With Project = Full implementation of control structures + internal water management + WUG participation + active DAE involvement. Attainable in 10 years.

The expected increases in yields are modest and remain within the potentials identified. The average increase in damage free paddy yield will be 0.13 t/ha for the without project situation and 0.40 t/ha for the options in with project situation. FAP 2 has estimated an increase of 0.58 t/ha in future situation.

Land utilization, area and production

A comparative presentation of land utilization in different project situations is presented in Table 6.6. Triple cropped area will rise sharply with proportionate decrease in single cropped area. This will result in cropping intensity changes from 184 in base situation to 191 in option 1, 205 in option 2A and 206 in option 2B. These changes in land utilization will result from changes in land types (described in Table 6.3) and cropping patterns. A summary on crop hectarage and production is presented in Table 6.7.

There will be gradual increase in areas for a number of crops except wheat and jute. A favourable rice/non-rice ratio will be achieved. Extensive use of HYVs of paddy will occur. Dependency on Boro will be reduced in paddy production but not in area. There will be substantial increase in Aman rice production.

Input requirement: In situations of increased cropping intensity and higher yield, input requirement will increase also. This is presented in Table 6.8. Additional paddy seed requirement will range from 7 - 23 tons. Additional requirements will be 430-699 tons for Urea, 140-390 tons for TSP and 97-174 tons for MP.

6.4 Fisheries development potentials

A The impact of proposed development options

The fisheries situation in Sirajganj CPP Project area is rather complex. The negative impact of the sealing of the *Jamuna* river is clearly visible in all fisheries statistics from the Old Pabna or Sirajganj district. The breaches of the last years changed the situation a little, from a fisheries point of view, a breach early in the season is comparable with normal flooding of the area. All development options must be regarded in this context and it makes the establishment of a "permanent" baseline difficult.

The fisheries production as estimated for 1992/1993, with the results of primary data from field surveys is considered to be comparable with the "without case" (stable BRE & no CPP) as no flooding at all occured during that year.

Table 6.6: A comparative presentation of land utilization in the CPP area, Sirajganj

	Base	Without project	With Project		
			Option 1	Option 2A	Option 2B
Gross area (ha)	12057	12057	12057	12057	12057
NCA (ha)	9579	9579	9579	9579	9579
Temporarily fallow (ha)	303	214	200	145	132
Single crop area	1068	999	845	45	40
% of NCA	11.1	10.4	8.8	0.5	0.4
Double crop area	8022	8175	8124	8544	8499
% of NCA	83.7	85.3	84.8	89.2	88.7
Triple crop area	186	192	410	845	908
% of NCA	1.9	2.0	4.3	8.8	9.5
Cropped area	17670	17925	18323	19670	19760
Cropping intensity(%)	184	187	191	205	206

Source: Project Computations

Table 6.7: Summary of impact on crop hectareage and production in the CPP area, Sirajganj

	Base Situation		Without Project		With Project					
					Option 1		Option 2 A		Option 2B	
	Area(ha)	Production (t)	Area(ha)	Production (t)	Area(ha)	Production (t)	Area(ha)	Production (t)	Area(ha)	Production (t)
Total rice area	8558	23444	8639	25109	8642	33114	9065	35830	8952	35992
Boro (HYV)	4501	19093	4501	20544	4504	21282	4731	22355	4591	21693
T.Aman (HYV)	1236	1841	1236	1932	2036	7708	2722	10305	3146	11908
T.Aman (Local)	2795	2480	2879	2605	2086	4103	1612	3170	1215	2390
Aus (Local)	26	30	23	28	16	21	0	0	0	0
Wheat	956	2321	946	2355	805	2307	724	2075	782	2241
Sugarcane	3711	183666	3768	191086	3815	199052	3917	203436	4011	208312
Jute	967	1371	948	1344	852	1512	781	1386	841	1493
Potato	785	7685	793	8041	932	9954	1156	12346	1032	11021
Mustard	1178	931	1202	978	1376	1170	1613	1371	1545	1313
Pulses	1027	1058	1027	1111	1169	1309	1401	1569	1510	1691
Veg.+Spices	349	1662	356	1784	474	2332	677	3410	731	3682
Others	138	-	246	-	260	-	334	-	360	-
Ratios										
Rice/Non-rice crop	1 :	1.06	1 :	1.07	1 :	1.12	1 :	1.17	1 :	1.21
Local/HYV rice	1 :	2.03	1 :	1.98	1 :	3.11	1 :	4.62	1 :	6.37
Boro T.Aman rice	1 :	0.90	1 :	0.91	1 :	0.92	1 :	0.92	1 :	0.95
Dependency on Boro	0.52	0.81	0.52	0.82	0.52	0.64	0.52	0.62	0.51	0.60

Source: Project Computation

- **Under option 1** the beel fish production increases from 12 t/year to 30 t/year if compared with the without case. This is mainly caused by an increased inundated area during the pre-monsoon as indicated by the hydrological model. This increase in inundated area does not occur within option 2A and 2B. The calculated incremental production will be zero or negative once this inundated area equals the inundated area under option 2A and 2B.

- The floodplain production is probably somewhat under estimated due to the fact that the "fisheries" model does not take directly into account the "new situation" of hatchling migration through the constructed regulators. The direct effect is difficult to quantify as recruitment/yield figures are not yet known which limits at present the use of the hatchling migration data as obtained through the Special Fisheries Study. However a prelimirary excersise done, indicate that the incremental production could be in the order of 17 t/year.

6.5 Socio-economic impact on target groups

6.5.1 Farmers

One of the main objective of the CPP is to facilitate agricultural production through field or chawk level water management. To a farmer, this means a safe crop environment planned, water utilization and a permanent opportunity to derive economic benefit from agriculture. This realisation among farmers will start a new batch of agricultural activities:

a) a shift from single to double and double to triple crop patterns.
b) a shift from local to HYV Aman, specially BR22, BR23 and BR25.
c) a shift from dominant variety *Purbachi* to BR14 and BR26 as HYVs of irrigated Boro.
d) a gradual release of land to diversified crop in dry season.

This means that the cropping intensity will gradually increase from 184 to a range of 191 to 206%.

All farm households operating F1 and F2 land would benefit from improved water management system. This will allow an additional crop to be grown.

All farm households would benefit from reduced flood damage. This is particularly relevant for small and marginal farm households which are often forced to make distress sales following severe flooding.

The main benefit will be improved productivity of land. Large farm households operate a relatively large proportion of the available land. Through their access to (institutional) credit they will be able make the necessary investments. By share-cropping out part of the land they own, they will be able to get additional returns in either capital or labour. On all these accounts the large farm households are likely to reap more benefits.

Medium and small farm households, are likely to benefit to the extent that they have access to the necessary credit. If institutional credit were available in time and at the going rate then these categories of farm households would benefit. To the extent that they have to rely on informal credit at high rates of interests, part of the benefits will be diverted to the money lenders.

Marginal farmers and pure share-croppers are also likely to benefit. There will be opportunity for additional full annual employment of 421 to 1322 person in with project situation. There will be work available through LCSs, SMG's EMG's and CMG's.

Farmers in the adjacent areas may face slightly higher levels of water during monsoon. This will limit their crop options to jute and local Aman. Overall the impact on agricultural production is likely to be minimal in adjacent areas.

6.5.3 Landless

Landless households inside the project will benefit much from the flood protection of their homesteads by a more secure BRE. They would also benefit from the reduced damage to infrastructure if the BRE does not breach. To the extent that they still owe some agricultural land they would also benefit from the more secure crop environment provided by such an improved BRE.

Landless might benefit indirectly through additional employment in the agricultural sector, be it from a secure BRE or compartmentalization. However, given the high percentage of non-farm households (around 70%) and the small percentage of medium and large farm households, it is unlikely that sufficient employment opportunities will be generated outside the farm households to increase the labour opportunities for landless significantly.

In as much as agriculture is the "engine" of the rural economy, the landless may benefit from forward and backward linkages and a growing demand for locally produced goods and services.

To the extent that landless are involved in subsistence fisheries (a little) they are likely to be affected positively by increased flood plain fisheries (see below; Fishermen). The (further) improvement of the road system through compartmentalization is likely to also have a positive impact.

Though not part of FAP 20 as such the landless living on the BRE will have to be resettled to prevent damage to the embankment. To the extent that this is done properly and for all concerned, and allows for future settlement as well, these landless will benefit.

6.5.4 Fishermen

The fish production of beel and floodplain will be influenced by the implementation of CPP. At present the professional fishermen are catching 300 t/year, of which 27 ton is obtained from the floodplain and 11 ton from the beels. The catch from the floodplain will be almost similar under option 1 and 2A, but will reduce to half with the

implementation of option 2B. Beel fish production could increase to 30 t/year with the implementation of option 1, where professional fishermen will catch 27.6 t/year. But with option 2A and 2B the beel fish production decreases with 25%. The decrease of floodplain and beel catch will negatively affect the professional fishermen community, who are even at present in a bad shape. Many professional fishermen have changed in the past their profession to: nichary, mason, daily laborer, weaver, etc, or they migrated out of the area, this process is most likely to be continued. Further decline in fish production will put this minority group into a difficult struggle for survival.
There are only 50 occasional fishermen household in the area and they will be similar reacting, because almost 50% of their catch comes from the floodplain and 15% from the beels.

In conclusion: professional and occasional fishermen will only be somewhat better of if option 1 is going to be implemented.

In Sirajganj 3%-10% of the rural households, or 2000 households, are engaged in subsistence fisheries which is substantial less then the average of 60 % for the whole of Bangladesh, a major reason is the scarcity of fish and waterbodies within the project area due to the construction of the BRE which caused that a large number of households shifted to other resources. Those households who are still fishing for their own consumption probably have no other opportunities. Those who are engaged in subsistence fishing are getting approximately. 0.55 kg/person/year, which is only about 7% of the average per capita fish consumption in Bangladesh. This amount will be similar with option 1 and 2A and will reduce to 0.5 kg/person/year with the implementation of option 2B and this difference is insignificant.

6.5.5 Women

CPP has paid specific attention to women allowing them to express their needs and their opinion. In the original set up four seperate interest groups were identified for involvement during the planning as: women, landless, farmers and fishermen. However, considering the impact of compartmentalization on women, one needs to look at women in light of her families profession.

The possible impact on farmers affects also female family members and the possible impact on fishermen will affect their female family members: The decrease in capture fish has a negative impact on diet and nutrition, since cash will be needed to buy fish. The decrease in income will affect the whole family and its well being. Increase in production in farmers will provide the family with more income.

The expected increase in rice production will be positive for women processing rice and gaining employment, unless processing is mechanised and women are put out of jobs. The female members of the farmers family, who need to process themeselves will experience an increase in workload for women. The increased rice production will result in more straw, husk and bran for poultry and duck feeding.

Female members of the farmers family will benefit from khals re-excavation for domestic water use and food processing if and when these khals are near to their homesteads.

A higher risk for diseases and infections can occur due to controlled flooding. Without health education on this higher risk, this development will have a negative impact on women, men and children and their productive activities.

The employment opportunities that arise from construction and maintenance will be beneficial to women if and when the project achieves at least the quota of 50% women's participation in the contracts reserved for LCS.

6.5.6 Urban population

The population in Sirajganj constitute about 45% of the population of the compartment, and this percentage is still rising and likely to continue to raise in the future. The town is relatively well protected now and the urban dwellers, and the industrial units and service sector, are likely to benefit from the psychological effect of a more secure BRE.

The environmental condition in the town is likely to improve considerably by the proposed re excavation of existing channels and building of flushing and drainage regulators. However, to substantially improve the environmental situation the municipality will have to implement an integrated water supply, drainage, sewerage, solid waste disposal programme.

There are no urban areas in the adjacent area that might be affected by the project.

6.6 Preliminary Environmental Impact Assessment

The Sirajganj CPP area is already impacted by the BRE. Since the construction of this embankment, regular *Jamuna* River floods are bunded off (except during distastrous BRE-breaches) and the natural floodplain ecosystem is transformed to a paddy landscape with consequences on fisheries, wetland habitats and their provision of common goods, land use pattern, livestock as well as on water and soil resources.

Therefore, it is difficult to assess impacts by the CPP project interventions, especially if we have in mind that the CPP follows a stepwise planning approach which leaves space for future amendments and adjustments during implementation and operation. At this stage, a preliminary assessment of likely impacts is possible.

Table 6.9 presents a rapid appraisal of all CPP options. These options consist of a set of individual measures which all have different impacts, depending on future operation of regulators. The overall impact is evaluated in relative terms to compare the magnitude of negative or positive impacts among the options. From the economic point of view, Option 2A is judged favourable because of a higher EIRR and B/C ratio. Hence a preliminary EIA is made of Option 2A (Table 6.10).

Table 6.9: Rapid Environmental Appraisal for the Development Options of CPP Sirajganj

Environmental Elements	OPTION 1	OPTION 2A	OPTION 2B
Containment of BRE-Breach Flood	+1	+4	+4
Regular Flooding of Croplands	+3	+2	+1
Drainage Improvement	+3	+2	+2
Groundwater Availability	-1	-2	-2
Soil Fertility Maintenance	-1	-2	-2
Surface Water Quality	?	?	?
Groundwater Quality	?	-1	-1
Aquatic Habitat Status	0	-2	-3
Wildlife Threat	-1	-2	-3
Terrestrial Habitat Status	+1	+2	+2
Biological Imbalances	-1	-2	-3
Capture Fisheries	-1	-2	-3
Culture Fisheries	0	0	0
Crop Diversification	+1	+1	+1
Crop Intensification	-1	-2	-2
Crop Production	+1	+2	+2
Homestead Plantation	0	0	0
Embankment Plantation	0	0	0
Biomass Energy Availability	0	-1	-2
Fodder Production	0	-1	-2
Communicable Diseases			
Water-based	0	0	0
Vector-borne	0	0	0
Non-Communicable Diseases			
Occupational Risks	-1	-2	-2
Water Pollution/Sanitation	0	0	0
Construction Impacts			
Land Aquisition/Losses	-1	-2	-4
Building Materials	-1	-3	-4
Pollution/Spillages	-2	-3	-4
External Impacts of Contained Rivers	0	-3	-5
Overall Index	Minor Impacts	Medium Impacts	Major Impacts

Scoring system = +5 to -5

Table 6.10: Preliminary EIA Matrix of the CPP Sirajganj (Option 2A)

ENVIRONMENTAL ELEMENTS	Priority Issue of CPP		Current Status 1 to 10	Without Project	EXTRA IMPACTS OF CPP		Subjective Score	Enhancement or Mitigation		Recommendation
	Planner	People			With Project (Option 2A)					
					Without Mitigation	With Mitigation		Possible	Costly	
Regular flooding of cropland	Yes	Yes	7	0			+2	desired goal of CPP		Monitoring of flood extent & land use changes
F0				+	+					
F1				+	-					
F2				-	-					
F3				-	-					
Beel				-		0				
Cumulative off site effects of contained events				0	-		-2			
Flood free land for homestead			3	0	+		+2			
Loss of land to river bank erosion			8	0	0		0			
Containment of floods in event of BRE-breach	Yes		8	0	+ off-site - local		+2			
River flood damage			7				+2			
Homesteads				0	+					
Cropland				0	+					
Infrastructure				0	+					
Rain flood damage to cropland			5	0	+		+2			
Drainage network conditions	Yes	Yes	7	-	+		+4			
Groundwater availability	Yes		2					partly by controlled flooding	low	Groundwater level monitoring
Flood season drawdown						0	-1.5			
Dry season drawdown				-	0					
Irrigation supply				0	0					
Domestic water supply				-	-	0				
Water quality	Yes						-1.0			Water quality monitoring; Be management practices; Sanita
River/khal water			3	-	-	0		Yes		
Ground water			3	-	-	0		Yes		
Beel water			6	-	-	0		Yes		
Soil quality							-1.5			Monitoring of soil fertility; B management practices
Physical status			3	-	-	0		Yes	moderate	
Bio-chemical fertility			4	-	-	0		Yes	moderate	
Soil contamination			2	-	-	0		Yes	moderate	
Aquatic habitat status	Yes		7				-1			Wetland conservation plan for key areas
Pre monsoon				-	-	0		Yes	moderate	
Monsoon				-	-	0		Yes	moderate	
Post monsoon				-	-	0		Yes	moderate	
Terrestrial habitat status			5				+1	desired goal of CPP		
Pre monsoon				0	+					
Monsoon				0	+					
Post-monsoon				0	+					
Wildlife			7				-1	Yes	moderate	Ecological survey; Enhancem of threatened aquatic habitats in key areas
Endangered species				-	-	0				
Threatened species				-	-	0				
Presently common species				-	-	0				
Biological imbalances	Yes		6	-	-	0		Yes	moderate	IPM programme
Capture fisheries	Yes	Yes		-			-2			Enhancement proposals for se beels (Fisheries Project)
River			5	0	0	0				
Beel			8	-	-	0		Yes		
Flood plain			9	-	-	-		Yes		
Culture fisheries			6	0	0	+	+2.5	Yes		
Crop production	Yes	Yes	3	0	+		+3	desired goal of CPP		Introduction of more non rice crop
Crop diversification			2	0	+					
Cropping pattern & intensity			4	0	+					

ENVIRONMENTAL ELEMENTS	Priority Issue of CPP		Current Status 1 to 10	Without Project	EXTRA IMPACTS OF CPP		Subjective Score	Enhancement or Mitigation		Recommendation
	Planner	People			With Project (Option 2A)					
					Without Mitigation	With Mitigation		Possible	Costly	
Homestead plantation			5	0	0	+	+2.5M	Yes		Homestead and embankment plantation
Embankment plantation			9	0	0	+	+2.5M	Yes	moderate	
Biomass energy production		Yes	8	-	0	+	+2.5M	Yes	moderate	
Fodder production			8	-	0	+	+2.5M	Yes	moderate	
Public health							+1M	Yes		Public health survey; Environmental manipulation & management; Sanitation facilities
Communicable disease										
Water based/washed			7							
Community vulnerability				-	-	0			moderate	
Environmental receptivity				-	0	+				
Vigilance of health service				0	0	+			moderate	
Communicable disease										
Vector - borne disease			4				0			Co-operation with health services and flushing of rivers
Community vulnerability				-	-					
Environmental receptivity				-	0	+				
Vigilance of health service				0	0	+				
Non-communicable disease							+1.5M			Safety precautions during construction; Integrated sanitation and waste management
Occupational risks			3	-	-	+		Yes	high	
Urban water pollution			6	-	-	+		Yes	high	
Rural water pollution	Yes		8	-	-	+		Yes	moderate	
Waste disposal facilities	Yes									Integrated sanitation and waste management
Urban			9	-	0		+1M	Yes		
Rural			5	-	0	+	+1M	Yes		
Water supply facilities		Yes						Yes	moderate	Urban and rural area water supply facilities
Urban			6	-	0					
Rural			8	-	0					
Navigation										Design and operation of sluices
Major river			2	0	0	0				
Beel/khal			7	-	-	+	+1M	Yes		

Notes:
- Priority issue = Only the most important issues are addressed here.
- Current status = Existing state of the environment, Subjective rating, 1 = excellent/no impairment, 10 = impared/extinct
- Impact rating = + positive change, 0 unchanged, - negative change
- Subjective score = The system follows EIA-guidelines by FAP-16, +5 to -5, criteria are sustainability, senaitivity, magnitude and reversibility type of change; scoring is without mitigation measures unless mentioned as M = Mitigation

Most important is the additional decrease in seasonal inundation and the consequent increase in terrestrial habitats to the potential benefit of intensified and more secured agricultural production. The accelerated shift to modern crop varieties, cropping systems and cultivation practices may result in increased biological imbalances and soil and water impairments, unless "best management practices" are widely used. Further potential negative impacts are associated with long-term impacts on groundwater recharge, impairments of domestic water uses, further decline in capture fisheries, a long-term extinction of permanent aquatic habitats (beels) and wildlife species dependant on such habitats. Potential impacts on public health are probably balanced (vector-borne risks can slightly increase or decrease due to FCD) and there is potential for environmental management, such as flushing and water level or inundation manipulations to reduce water-related diseases risks.

Mitigation and associated measures include: providing sufficient sluice gates with adequate design discharge to reestablish part of the *Jamuna* River flood; and operational rules adjusted to sound environmental management. Mitigating and enhancement initiatives should be implemented. Although the approach of the CPP permits considerable flexibility in impact reduction, there are several participatory and institutional preconditions which must be fulfilled that environmentally sound development can be achieved to the benefit of all affected people.

7 OPERATION AND MAINTENANCE

7.1 General

In the ToR a compartment is described as a "management unit". Of such a compartment, it is said that "... *the involvement of the beneficiaries is considered essential for its success.*" [ToR, p.3]. Consequently, a sustainable system in the short and longterm should involve the beneficiaries in both the operation and maintenance process.

In this chapter the technical side of operating the different types of structures is dealt with first. Next the institutional side of operation and the maintenanace is discussed.

7.2 Operation of the structures

The structures as proposed (Chapter 4) should permit a flexible water management of the compartment. It should be such that different requirements can be met for the proposed structures.

The range of hydrological situations which may have to be dealt with ranges from dry to flood levels in a wide variety of circumstances. Apart from these possibilities, a time dynamic situation may arise whereby certain situations are expected in time dynamic fashion and need to be anticipated upon. This requires a different approach. The operational range of gate operations and other structures may consequently vary from closed to open. Depending on the hydrological conditions, water will be allowed to enter the compartment and excess rainwater will be drained whenever possible into the existing drainage system.

A flood situation outside the compartment may also occur whereby the operational guideline would be to open all gates until an extreme flood event occurs where upon all peripheral gates will be closed. However, it should be understood that a strong institutional set-up is a pre-requisite for such gated structures.

The proposed structures will be grouped as follows:

- Peripheral Control Structure with Regional Requirements.
- BRE Inlet Structures.
- Compartmental Outlet Structures.
- Subcompartmental Regulators.
- Sirajganj Town Flushing Sluice.
- Waterretention Structure.
- Minor Irrigation and Drainage Works.

7.3 Technical Guidelines

The following indication for the operation of the structures will be based on a typical year that starts with a compartment which is in a dry state (at the end of the dry season) and main river water level in the *Jamuna* and *Ichamati* are low; with abundant rainfall during

the pre-monsoon and rising water levels in the rivers can be expected. During the monsoon and declining rainfall and river levels during the post-monsoon.

Peripheral Control Structure

This is the main structure at the confluence of the Ichamati river/khal and located at *Bir Subgacha* (SC 2). Its function is to take in regulated flow and divert excessive flow caused by runoff from the northern part of the CPP Sirajganj area. The diversion is necessary due to breach mitigation measures which have an impact on the subcompartmental boundary structures.

BRE Inlet Structures

Proposed locations for these structures are at Par Shimla (SC 1), Vatpiary (SC 5), Pachil (SC 5). Their functioning will depend on the accessibility of water from the *Jamuna* river to this location. The accessibility of *Jamuna* river water is assumed to reach the location with a return period of 2 years. The duration of the inflow should preperably be 30-45 days.

The main function of the structures will be to control inflow from the *Jamuna* with a twofold objective: 1) fish migration; and 2) supplemental irrigation.

1) The critical period for fish migration from the *Jamuna* to the floodplain area is June/July and may even extend to August. As the fish fry comes with the rising waterlevel in the *Jamuna* river, it is of utmost importance to allow these rising waterlevels into the compartment area uninterruptedly. If the waterlevel difference between riverside and countryside is too much then preferably the BRE inlets should be closed due to the erosion hazard on upstream and downstream side of the structure.

2) It is possible that if the *Jamuna* water level is relatively high in the pre or post monsoon period in comparison with the average ground level within the compartment supplemental irrigation can take place. Therefore the sill level will be based on requirements during the above mentioned months (July/August).

Compartmental Outlet Structures

This implies the structures which mainly take care of the drainage situation on the downstream side of the (sub)compartments. The structures at Khangati (SC 4), *Ichamati* (SC 6), Beel Gajaria (SC 8) are all located on the western side of the compartment, draining directly in the Ichamuti river.

These structures may serve both as inlet and outlet structures depending on the compartment/river water level.

Before mid-July most probably these structures will be open. They may serve as an outlet for the compartment during high local rainfall or as in inlet, permitting some fish migration, during an early flood situation whereby the river waterlevel is high and inside compartmental waterlevel is low.

After mid July the emphasis of these structures shall be on drainage based on the head difference over the main inlet. At a river stage higher than the compartment level they shall be closed and be opened again when the situation reverses.

In case of breaches, the operating strategy should be that all these gates are open in order to have the drainage level as low as possible. At the end of the monsoon these structures shall be opened completely.

Subcompartmental Regulators

Subcompartmental regulators include those which regulate at *Itali* (SC 3-2), *Peoplebaria* (SC 3-2), *Degreepara* (SC 3-5), *Chalk Fulkocha* (SC 5-6), *Jhingati* (SC 5-7) and *Bahuli* (SC 7-8).

These structures do consist of two parts; a low section with a regulator based on the pre-monsoon discharge requirement and a weir section with a fixed weir level is based on the required water level in the upstream part during the monsoon.

The regulator part will be open during pre-and post-monsoon periods and closed from mid July onwards. During an extreme flood when the emergency spill sections are functioning, the weir section will permit a full discharge.

Most of these subcompartmental regulating structures have a special function. They cater to the need of the BRE mitigation measures and are designed for these special circumstances.

Waterretention Structure.

The planned waterretention structure is located at *Shampur* (SC 2), at the downstream end of the *Ichamati* branch.

The main function of this structure which is located at the end of the Ichamuti branch, can be efficiently used to store/retain water in this depression. This water can be beneficially used by farmers in the neighbouring areas. This structure functions during pre monsoon stage so that Boro crops may benefit from available water.

The high waterlevel in the Ichamuti khal will ultimately contribute to a higher groundwaterlevel.
The increased moisture content in the soil resulting from the high water table, enables the farmers to raise certain rabi crops even without any irrigation.

Sirajganj Town Flushing Inlet

The location of this sluice is located on the edge of *Sirajganj* town where the BRE is located (SC 9).

This inlet requires a special design based on its specific function as a flushing sluice for the existing open sewage system in *Sirajganj* town. It is foreseen that the intake will be placed such that water can enter the system with a 1:2 return period. It should be made clear that the internal watermanagement system will determine if this inlet can also be used as an outlet. In other words, the sluice will actually be opened during raising waterlevels in June-July and be drained again with receding waterlevels in August/September or any other period in which considerable waterlevel drops are observed. These waterlevel drop between inside and outside waterlevels is necessary in order to get sufficient streamflow within the drainage system.

Minor Irrigation, Retention and Drainage Outlets

There will be many smaller sized water retention structures, irrigation inlets and drainage outlets spread out over all the subcompartments (except SC 9, Sirajganj town). Their exact location will be determined by the interst groups at fieldlevel.

The operation procedures for these structures may be similar to the compartmental outlet structures. Since the operation procedures for the compartmental outlet structures are quite complicated it is suggested that the minor drainage outlets be open during pre and post monsoon and be closed continuously from mid July onwards. Their capacity is limited and it may be expected that the necessary discharge during the monsoon passes via overland flow to the compartmental outlet structures.

The irrigation inlets will normally be closed. Only during dry spells in the monsoon period they may be opened for flooding of the compartment. Irrigation passes mainly serve a purpose during the dry season to permit flow from low-lift pumps through the embankment. They are normally closed during the wet season.

7.4 Institutional guidelines

The complexity of the operations for the structures and the scope of their impact will determine which institutional arrangements for its operation are desirable. The actual competence of a particular institution will determine whether responsibilities for operation will indeed be delegated to that institution, possibly after training and with provisions for technical advice.

In practical terms this means that operation of structures that affect areas larger than the compartment will, for the time being, be done by the BWDB. Lacking any representative institutions beyond the compartmental level and taking into account the sophistication of operation requirement, the BWDB provides the only practical option.

The envisaged Compartment Water Management Committee can, when built up to a sufficient degree of capability and representation, be charged with decisions regarding operation that affect the compartment as an entity. FAP 20 intends to install the Compartment Water Management Committee after mid 1995, when all sub-compartments will be established physically and institutionally, and when relevant training is expected to be completed. The precursor to this Committee is the Steering Committee which might gradually become involved in advice and guidance regarding operation of main structures. However, three conditions will need to be met in the case of compartmental institutions assuming some degree of responsibility for operation:

- the establishment of operational guidelines
- the establishment of consultative arrangements with Sub Compartment Water Committees.
- effective understanding with other relevant agencies, such as LGED, Union Councils.

For structures that substantially affect more than one sub-compartment either the concerned SCWMC will establish a mechanism for joint operation, or the CWMC will assume responsibility for these structures. The latter will be the case if the number of involved sub-compartments and/or the competence or compatibility of the concerned sub-compartments do not allow the decentralization of these decisions and their monitoring.

For structures that essentially affect only a particular sub-compartment, the SCWMC will be in charge. In a number of cases the "boundary conditions" for the operation of such structures will be determined by the CWMC. This will be determined on a case by case basis, depending on technical criteria. The SCWMC will oversee operation, consulting with CWMC and BWDB on the one hand and with Water Users Groups on the other.

Structures that affect only an area within a sub-compartment will be the responsibility of a Water Users Group. In conflict situations the SCWMC will either set boundary conditions for the Water Users Group operating the structure, or will establish a mechanism for the various affected groups to work out common solutions or may even assume operational responsibility for the structure if all other proposed measures fail.

Summarizing the operating rule will be that the responsibility for operation of structures will be put at the lowest possible level (which will normally be the level which is exclusively affected by the structure) with consultation towards the next lower level and supervision by the next higher level. In the following diagram these various aspects are displayed.

STRUCTURE TYPE	deciding agency	consultation	operat. criteria	executing agency	controlling
Peripheral control structure	BWDB	MIWDFC	regional WL	BWDB operator	MIWDFC
BRE inlet structure	BWDB	SCWMC	US/DS WL*	CWMC operator	BWDB
compartmental outlet structure	CWMC	SCWMC	US/DS WL	CWMC operator	BWDB
sub-compartmental regulator	SCWMC	WUG	US/DS WL	SCWMC operator	CWMC
waterretention structure	SCWMC	BWDB	US/DS WL	SCWMC operator	CWMC
Sirajganj town flushing sluice	CWMC	DPHE Municipality	US/DS WL	CWMC operator	CWMC
minor drainage outlet	SCWMC	WUG	US/DS WL	SCWMC operator	CWMC
irrigation inlet	SCWMC	WUG	rain/ flood	SCWMC operator	CWMB
irrigation pass	WUG	farmers	rain/ flood	WUG operator	SCWMC

* US/DS WL : Upstream and Downstream Water Level

7.5 Maintenance

7.5.1 General

Maintenance in the compartment is required for structures, embankments and channels.

Maintenance can be divided in:

- preventive maintenance
- periodic maintenance
- emergency maintenance and
- rehabilitation.

Preventive maintenance entails replacement of minor spare-parts, greasing, painting, filling of earthwork patches, turfing etc. at fixed time intervals.

Periodic maintenance is the verification of the structural works on their functioning and general performance, repairing elements as required.

Emergency maintenance is required when the proper functioning of the structure can not be guaranteed any more because of the degradation or mal functioning of some parts of the structure.

Rehabilitation is done when the design standard is not met after emergency maintenance or when the design standard need be adjusted.

7.5.2 Responsibilities

Maintenance of structures has traditionally been done by the BWDB for major works and, for minor structures, by the Local Government Engineering Department (LGED). It is proposed that institutions initiated by CPP are also be involved in maintenance, to the degree such participants are organized in a structured and accountable institution:

- CWMC (Compartmental Water Management Committee), with the Steering Committee as its predecessor,
- SCWMC (SubCompartmental Water Management Committee),
- WUG (Water Users Groups)

It needs to be worked out to what extent local contributions will be sought through these various institutions. The long-term objective is that the maintenance costs of sub-compartmental specific structures will become the responsibility of the SCWMC, with subsidy from the GOB (via BWDB). Subsidy arrangements will need to be elaborated. Local contributions can be collected via levies and labour input collected at the sub-compartmental level.

For more sophisticated structures at the sub-compartmental level, that require more specialized maintenance, the BWDB and LGED will be involved. However the SCWMC will be responsible. Subsidy arrangement will have to be established, whereby labour will be an accepted form of local contribution.

For structures with compartmental significance the BWDB will perform maintenance, unless other arrangements are made, while responsibility will eventually be with the CWMC, which will in due course replace the Steering Committee. No local contribution is envisaged for O&M at this level.

7.5.3 Execution

For the actual realization of maintenance three types of maintenance groups may be involved:

- SMG: Structures Maintenance Group.
- EMG: Embankment Maintenance Group.
- CMG: Channel Maintenance Group.

The distribution of roles for these groups or agencies for specific tasks is proposed as follows:

For structures, different aspects are important for the implementation mode of maintenance:

- a controlled or semi-controlled structure.
- the size and impact of the structure.

This will determine the degree of specialisation of the work. Most tasks will be so much specialised that the BWDB has to be involved, while in a number of situations LGED will do the work (e.g. culverts, bridges). Only for related earthwork of controlled and semi-controlled, medium and main structures, many other agencies or groups be involved. Provided that they receive a proper training, preventive maintenance may be done by a SMG.

Only the very minor structures (e.g. irrigation passes) may possibly be fully maintained by a SMG or even a WUG under responsibility of a SCWMC.

Maintenance of **embankments** requires a considerable amount of non specialised work for filling of erosion trenches and replanting of the turf layer. This may be done by EMG's and eventually WUG's. In case of an embankment failure, overtopping during a high flood or up-grading of the design standard, emergency maintenance and rehabilitation will be required. In order to maintain the design standard, specialised, BWDB supervision is required.

For the maintenance of **channels** a distinction can be made between local channels for the drainage of a *chawk* area and (sub) compartmental channels for the drainage of a larger area. The former can be excavated by a group of interested users. The (sub-) compartmental channel will not be excavated in this way because it has more regional implications. Payment for the work by CMG's is required.

The principal maintenance activity is excavation of earthwork. Channels that are completely silted up, may be rehabilitated under supervision of the CWMC or the LGED.

Table 7.1 summarizes the maintenance tasks and the institutions involved. The most appropriate institution for maintenance, rehabilitation and monitoring has also been indicated.

Table 7.1: Distribution of Responsibilities for Maintenance

Maintenance for	Maintenance	Rehabilitation	Monitoring
Major structures	SMG/BWDB	BWDB	BWDB/CWMC
Medium structures	SMG/BWDB/LGED	BWDB/LGED	BWDB/LGED/ CWMC
Roads	DRHW	DRHW	DRHW/CWMC
Minor structures	SMG/LGED	LGED/BWDB	SCWMC/BWDB
Embankments	EMG	BWDB/CWMB	BWDB/CWMC/SCWMC
Earthwork major/ medium structures	SMG	SMG/BWDB	BWDB/CWMC/SCWMC
(Sub-)compartment channel	CMG	SCWMC/LGED/ CWMB	SCWMC/CWMC
Beel channel	WUG	SCWMC/LGED/ WUG	SCWMC
Retention bunds	WUG/farmer	WUG/SCWMC	SCWMC/DAE

8 MULTI-CRITERIA ANALYSIS

8.1 General

In this chapter the overall impact of different options for development of the Sirajganj CPP project is analysed.

The approach followed is that of a Multi Criteria Analysis (MCA) as prescribed by the GPA (FPCO, 1992). It main objective is to analyse the impact of the project by evaluating a full set of criteria in order to allow for a ranking of project options. It should be understood that the project aims at the creation of permanently positive changes in terms of mainly flood alleviation and improved water management. Impact assessement is consequently directed towards the evaluation of the future situation with improved conditions.

Although the core of the analysis consists of an economic evaluation of mainly the expected impact on agriculture and the assessement of damage prevented in the future, all other aspects with bearing on the project have been included as well. They have been analyzed as thoroughly as those mentioned above. As this task included all fields of expertise involved, the analysis truly reflects a multidisciplinary approach.

Only some of the evaluated criteria may be quantified in sufficient accuracy in monetary or physical terms (see Section 8.2). In order to broaden the evaluation framework as wide as this may be considered beneficial towards a comprehensive assessement, also a qualitative judgement has been presented (see Section 8.3).

It should be noted here that the quantifiable criteria comprise data allowing explicitly a separate economic evaluation but includes indicators encompassing a wider framework, even on the private sector. A table has been prepared for each option under review giving quantitative judgement in absolute or relative figures and stating the impact of the non-quantifiable indicators as their ranking in a scale of -5 (irreversible damage) to +5 (highest benefit). This procedure is in compliance with the proposed method of the FAP Guidelines on the matter.

The quantative and qualitative results are summarized in Tables 8.1 and 8.2 respectively, while details are presented in the Tables 1 (one per option) in Annex 9.

All conclusions forwarded are therefore based on the latest available information with bearing on the project region. This, however, does not exclude a continued verification of all important data as the project advances.

Table 8.1: MULTI-CRITERIA ANALYSIS - SUMMARY (Quantitative Aspects)

Data Type	Variable	Unit	Option 1	2 A	2 B
1. Economic					
	EIRR	%	5.9	15.7	15.2
	NPV	m.Tk	-73.4	56.6	51.5
	Benefit/Cost Ratio		0.69	1.18	1.15
2. Quantitative					
2.1 Construction (financial values)	Investment	m.Tk	230.2	280.6	297.6
	Time for completion	years	3.0	3.0	3.0
	Labour intensity (000)	m/d/a	2,873	3,311	3,494
	Foreign exchange as % of total investment	%	39.0	37.6	35.7
2.2 Operation & Maintenance	Total cost	m.Tk/a	7.5	13.2	13.8
	Labour intensity (000)	m/d/a	153.3	232.0	243.0
	Labour cost as per cent of total O&M costs	%	80.7	62.8	82.2
2.3 Aquaculture	Value added (economic)	m.Tk/a	24,287	24,450	24,581
	Employment generation (000)	m/d/a	126.3	371.6	396.7
	Diversification 1)	ratio	1:12	1.17	1.21
	Draught power requirements	P/d/a	12,553	43,168	43,545
	Ratio local/HYV in rice production	ratio	3.1	4.6	6.4
2.4 Fishery	Capture fish (additional)	MT/a	18.9	-2.7	-17.7
	Aquaculture (additional)	MT/a	0	0	0
2.5 Damage Prevention	Physical infrastructure	m.Tk	3.5	3.5	3.5
	Private property	m.Tk	0.5	0.5	0.5
	Crop production	m.Tk	2.9	2.9	2.9
2.6 Mitigation measures	Non structural (financial)	m.Tk	9.5	9.5	9.5
	Adjacent areas (financial)	m.Tk	7.1	7.1	7.1

1) rice crops to non-rice crops
Additional explanation is given in Section 8.2

Table 8.2: MULTI-CRITERIA ANALYSIS - SUMMARY (Qualitative Aspects)

Data Type	Variable	Option		
		1	2 A	2 B
3. Qualitative				
3.1 Natural resources and Environment	Flood plain nutrient recharge	-1	-2	-2
	Flood plain sand deposits	0	+2	+2
	Waterway sedimentation	0	-1	-1
	Groundwater availability	-1	-2	-2
	Surface water quantity	0	0	0
	Surface water quality * Sirajganj town	+2	+2	+2
	* rural areas	0	0	0
	Flora diversity	-1	-2	-3
	Fauna diversity	-1	-2	-3
	Wetland protection	-1	-3	-4
	Common resources availability	-1	-2	-2
3.2 Agriculture	Dependency on agricultural services	-1	-2	-2
	Seasonal distribution of labour	+2	+2	+2
	Livestock	0	0	0
	Soil fertility	+2	+1	+1
	Homestead gardening	0	0	0
3.3 Fisheries	Nutritional impact on subsistence level	+1	-1	3
	Fish recruitment	+1	+1	-5
3.4 Women	Additional work load	-1	-2	-2
	Social mobility	+1	+2	+2
3.5 Communicat.	Road transport	-2	+2	+3
	Internal navigation	-1	0	0
3.6 Health	Nutrition	0	+1	+1
	Domestic water supply	0	0	0
	Vector-borne diseases	0	0	0
	Water-based diseases	-1	-1	-1
3.7 Institutions	Insitutional requirements on local level	-2	-3	-4
	Interdepartmental dependancy	-2	-2	-2
3.8 Social issues	Social conflict	-1	-2	-2
	Income distribution	-2	-2	-2
3.9 Others	Flood retention	+1	+2	+2
	Cultural heritage	0	0	0

Additional explanation is given in Section 8.3

8.2 Quantitative judgement

8.2.1 Economic criteria

The guidelines propose two economic decision-making criteria, the Economic Rate of Internal Return (EIRR) and the Net Present Value (NPV). In the present analysis the Benefit/Cost Ratio has been added as it allows a more valuable global economic judgement.

All prices used in the corresponding calculations are those proposed in the GPA, (FPCO, May'92). Financial costs are corrected with conversion factors provided by the same source in order to reflect the economic opportunity costs of resources and commodities. The cost of capital is fixed at 12 %.

The corresponding figures for the three options are self-explanatory and are given as presented hereafter:

Criteria	Unit	Option					
		1		2A		2B	
		econ.	finac.	econ.	finan.	econ.	finan.
EIRR	%	5.9	4.3	15.7	13.2	15.2	12.0
NPV	Tk mln	-73	-115	57	25	52	0
B/C ratio		0.69	0.62	1.18	1.05	1.15	1.00

If the cost for development of Sirajganj town (18.6 Tk mln.) would be eleminated, the results would be slightly changed.

Criteria	Unit	Option					
		1		2A		2B	
		econ.	finac.	econ.	finan.	econ.	finan.
EIRR	%	7.3	5.4	17.4	14.4	16.8	13.1
NPV	Tk mln	-53	-91	77	48	72	24
B/C ratio		0.76	0.67	1.27	1.12	1.23	1.05

8.2.2 Construction

Investment Costs

Investment costs are determined by the flood-control and water management structural measures required to achieve the given objectives. Structural requirements and designs have been explained in detail in Chapter 4 and in more detail in Annex 3. The implementation schedule and detailed cost estimates are presented in Chapter 5.

For a wider coverage of different implementation, three alternative technical options have been elaborated. They differ mainly in the inclusion of an embankment on the left bank of the Ichamati River and its optional location in the area. The alternative options and the reasoning for varying combinations is not repeated here. Their overall financial costs per option as well as the breakdown into their main components are summarized in Table 3 related to each option in Annex 9. Total financial costs per option are as follows (in million Taka):

Option	Investment	Engineering	Total
1	200.2	30.0	230.2
2A	244.0	36.6	280.6
2B	258.8	38.8	297.6

In the computations of investment costs, neither replacement costs nor salvage values have been considered for the proposed structures, as all components are believed to last at least the economic life span of the project, assumed to be 30 years.

Directly related to the construction are engineering fees, which, in compliance with the Guidelines for Project Assessment, have been fixed at 15 %. Other investment costs, like buildings, vehicles or equipment have not been determined so far.

Due also to not yet sufficiently detailed information on construction materials and their origin, following factors have been applied to convert financial into economic prices:

- all labour intensive work (embankment, erosion control, drainage) = Standard Conversion Factor for unskilled labour, equal to 0.65, and
- all others = SCF Engineering and Administration: 0.87

Time for completion

The period planned for implementation is estimated to be three years for each option. Additional information on the timing of investments and the portion expected to be required in foreign exchange is provided in Table 3 for each option in Annex 9.

Labour intensity

This criteria has been selected to show the dependancy of structural measures on the employment of local labour of all three options. No need to stress the positive effect the creation of additional employment opportunities will have mostly on the poorer section of the population. The manual labour required to implement the structural measures per option is expressed in man days per option. The corresponding figures are:

2,873000 man days, Option 1,
3,311000 man days, Option 2A,
3,494000 man days, Option 2B

Foreign Exchange in Total Investment Costs

The percentage in foreign exchange indicating the dependancy on external assistance, has been estimated based on the experience of the consultants in similar assignments but most of all on rates identified by FAP 3 (Preliminary Supporting Report VII, Engineering, July 1992). It is believed that the overall rate of foreign exchange in Option 1 will be about 39 % while it will be between 37.6 and 35.7 % in Options 2A and 2B of total investment costs respectively.

8.2.3 Recurrent Costs

Because of the non-availabilty of yet exact information on specified operation and maintenance costs (O&M), estimates have been made by means of percentage rates of the corresponding investment. The rates applied, originate from the Guidelines quoted above and are as follows:

- Erosion control	10 %
- Embankment, drainage, mitigation measures	6 %
- Roads	5 %
- Vehicles, equipment [1]	4 %
- Regulators, culverts	3 %
- Buildings, bridges	2 %

1) not considering direct operational expenses

Other recurrent costs are expenses for technical staff, required to supervise and partly to operate the system. The number of staff required, their designation and corresponding wage rates as proposed by the Project Team, are shown hereafter:

Technical Staff Requirements:

Designation	Number of staff per option			Wage rate Tk/month
	1	2A	2B	
Sluice Khalashi*	6	15	15	2,000
Assistant	2	5	5	3,000
Emb. Khalashi	15	20	20	2,000
Assistant	2	2	2	3,000
Section Officer	2	2	2	5,000
Surveyor	2	2	2	3,000
Other	1	1	1	2,000
Sub division Officer	1	1	1	7,000
Office Assistant	2	2	2	3,000
Other	3	3	3	2,000

*Sluice Khalashis will only be engaged for five months per year during the monsoon period.

The conversion factor applied to convert costs of technical staff into economic costs is the SCF for skilled personnel, equal to 0.87.

Additional recurrent costs are to be considered for administrative overheads, estimated to be 10 % of the costs for Technical staff.

Total Recurrent Costs

All recurrent costs (in economic terms) of importance are summarized as follows:

Option	O&M	Technical Staff	Admin.Overhead	Total
1	6.7	0.7	0.1	7.5
2A	12.2	1.0	0.1	13.3
2B	12.7	1.1	0.1	13.8

It should be noted that the recurrent costs cited above represent the maximum costs as from project year three onwards, as the construction will be completed by then. For more details on the development of recurrent costs see Table 10, for each option in Annex 9.

Labour intensity of O & M

The corresponding figures for manual labour for mainly maintenance activities per option have been computed to be 153,300 man days per year for option 1, 232,000 man days per year for option 2 A and 243,000 man days per year for option 2 B.

Above mentioned figures have been computed on the basis of daily work performances for labour-intensive operations where available, but have to a larger extent been estimated according to the estimated percentage of manual labour in total O & M costs and given wage rates for daily labour as proposed in the guidelines.

Labour cost as per cent of O & M costs

The labour intensity rate reflects the dependance of O & M on local labour and underline the absolute figures given above on the creation of additional employment per option. The following figures per option have been determined:

Option 1 :	80.7 %
Option 2A:	82.8 %
Option 2B:	82.2 %

8.2.4 Agriculture

The most important positive effects expected by improved water-management, as explained in all detail in Annex 4, will result in more favourable conditions for agricultural production by lowering of waterlevels in Kharif II season combined with gradual drainage of water in the beginning of the Rabi season. This will, of course, not increase the cultivable area. It will, however, allow a further intensification of agricultural production by permitting a switch from local to HYV. This may be accompanied by a more intensified use of the Rabi season.

Expected agricultural benefits have been estimated and evaluated on the basis of model simulations of water levels. The procedure has been explained in detail in Annex 4. The overall impact per option has been summarized in Annex 9 (Tables 6 and 7).

Expected developments in total cropped area as well as per crop in addition to expected yield levels have been determined, based on the simulated water conditions per option. The criteria retained here for the impact assessement concentrates on the most important indicators as follows.

Value Added

The average value added of all crops considerably improves in all "with" project options, due to an improvement in yields (local varieties to HYV) and a switch from less to more profitable crops. The values are heavily influenced by the high proportion of HYV Boro rice (about 22 - 24 % of cropped area) and sugarcane (20 - 21 %), both crops yielding the highest returns.

Base situation	:	Tk/ha 19,985
Option 1	:	Tk/ha 24,287
Option 2A	:	Tk/ha 24,450
Option 2B	:	Tk/ha 24,589

The figure for the base situation has been included to allow a judgement on the changes believed to be attributable to the project.

The value added, defined as the final produce less the value of material inputs is used to quantify the agricultural benefit in monetary terms. The assumptions used in the computation of the value added (and gross margins) for all individual crops included in the evaluation, are shown in Tables 5 (in financial and economic terms), Annex 9, informing on the parameters applied.

Employment generation

It may be safe to assume that agriculture will not be able to absorb the growing supply of manual labour. On the other hand, it is highly unlikely that the little (semi-) industrial activities in the project area, even in combination with the informal sector, will bring the solution to this problem in the future either. Thus, any generation of additional employment possibilities must be judged extremely favourable, especially if this is in favour of the poorest strata of the population, the landless people. Agriculture favours this development in general terms. The figures on additional employment in agriculture in man days per year derived from the different development options are shown below:

Option 1 :	126,273 mandays per year
Option 2A:	371,637 mandays per year
Option 2B:	396,694 manddays per year

Diversification

As virtually all important non-rice crops like wheat, oilseeds, pulses, potato and most vegetables are winter (Rabi) crops, this will leave large room for crop diversification, especially as these crops are grown mainly intercropped with sugarcane. Assuming self-sufficiency levels in staple food (cereals), crop diversification may become a viable alternative for many farmers. The predicted trend for all options, illustrated by the ratio of rice crops to non-rice crops, is believed to be as follows:

Base Situation	1 : 1.06 ratio of rice to non-rice crops
Option 1 :	1 : 1.12
Option 2 A:	1 : 1.17
Option 2 B:	1 : 1.21

The development towards larger portions of non-rice crops must be evaluated positively as diversification generally helps to conserve or even improve soil fertility, reduces risks of crop damages by pests and diseases and allows a more diversified daily diet for the rural population.

Draft power

It has been observed that generally no reduction in cropped area took place, not even after disastrous floods. However, due to low supply of draft animals, cows are used additionally, in spite of effects on milk production and fertility. The requirement for draft

power because of a growing rice area will be more. Additional demand for draft power per option has been calculated as follows:

Option 1 :	12,553 pair days per year
Option 2A:	43,168
Option 2B:	43,545

Additional demand of draft power must consequently be regarded as having a negative impact on yield developments as qualitatively poor land-preparation (as potentially resulting from increasing shortage of draft power) will show an instant corresponding impact, especially in HYVs. A study is proposed to look into possibilities of meeting the additional demand for draft power.

HYV - local rice varieties

The ratio of local varieties to HYV is given as 1 : 2.03 HYV (in rice crops) for the base situation. The future ratio is expected to be for:

Option 1 :	1 : 3.11
Option 2 A:	1: 4.62
Option 2 B:	1 : 6.37

While an increased switch over to HYV may carry some risks (see soil fertility, dependancy on services) the most striking benefit is of course in the incremental production. Higher yields, the most outstanding difference between HYV and to local varieties, will allow higher productivity of land and labour and will render some activities more profitable, even on farm level.

8.2.5 Fisheries

The impact of fisheries of compartmentalization in the Sirajganj project area especially the structural measures of flood protection and improved water management as proposed by the CPP has been described in detail in Section 6.5 and in Annex 5. It has been concluded that the overall impact will be slightly negative if compared with the future situation without project.

The additional annual production is estimated as follows (t/year)

Option	Captured fish	Aquaculture
1	18.9	0
2 A	-2.7	0
2 B	-17.7	0

Further details may be derived from Table 3, General Information in Annex 9.

Above data has been computed based on waterlevels and inundated area per option as produced by the hydrological model.

8.2.6 Damage Prevention

Floods in the context of compartmentalization will be understood as either the single or combined effect of external floods, caused by overtopping of riverbanks due to events mainly or entirely outside the project area and internal floods, originating from heavy rains inside the project area.

Assessment of damages from both external and internal floods seems complicated in two aspects. Firstly as to the sources of figures about flood damages and secondly, in view to the extent of damages prevented through the project activities. The flood damages in Sirajganj Thana have been summarized in Table 8.3.

The reason for high figures may be explained by the obvious fact that visual damage assessment normally tends to overestimate the value in monetary terms. In benefit assessment utmost care should be applied to use realistic data only. In case such data may not be derived from reliable information by means of standardised procedures, common sense is applied to judge the data available.

Table 8.3: Flood damages in Sirajganj Thana

Items damaged	Unit	Year			
		1987	1988	1990	1991
Affected area	Sq.km	144	520	90	174
Union	No	10	10	10	10
Village	No	250	NA	61	192
Population	000	121	235	25	44
Crop damage	m.Tk	109.22	118.50	22.93	27.40
Livestock & poultry	m.Tk	0.29	0.76	NA	0.04
Private rural house	m.Tk	4.74	31.40	6.14	4.25
Infrastructures	m.Tk	85.00	323.10	16.28	42.47
Total damage	**m.Tk**	**199.25**	**473.76**	**45.35**	**74.16**

Source: Sirajganj Thana Project Implementation Office (PIO) and Sirajganj Pourashava Flood Damage Record of Flood 1988

Another aspect is the capability of compartments as such to prevent damages of course of equal importance. Crucial point may not be the methodological approach, but rather the source of the data, explained above, and the calculation of the figures themselves. The availables Thana data are adjusted to accommodate damage within the CPP area.

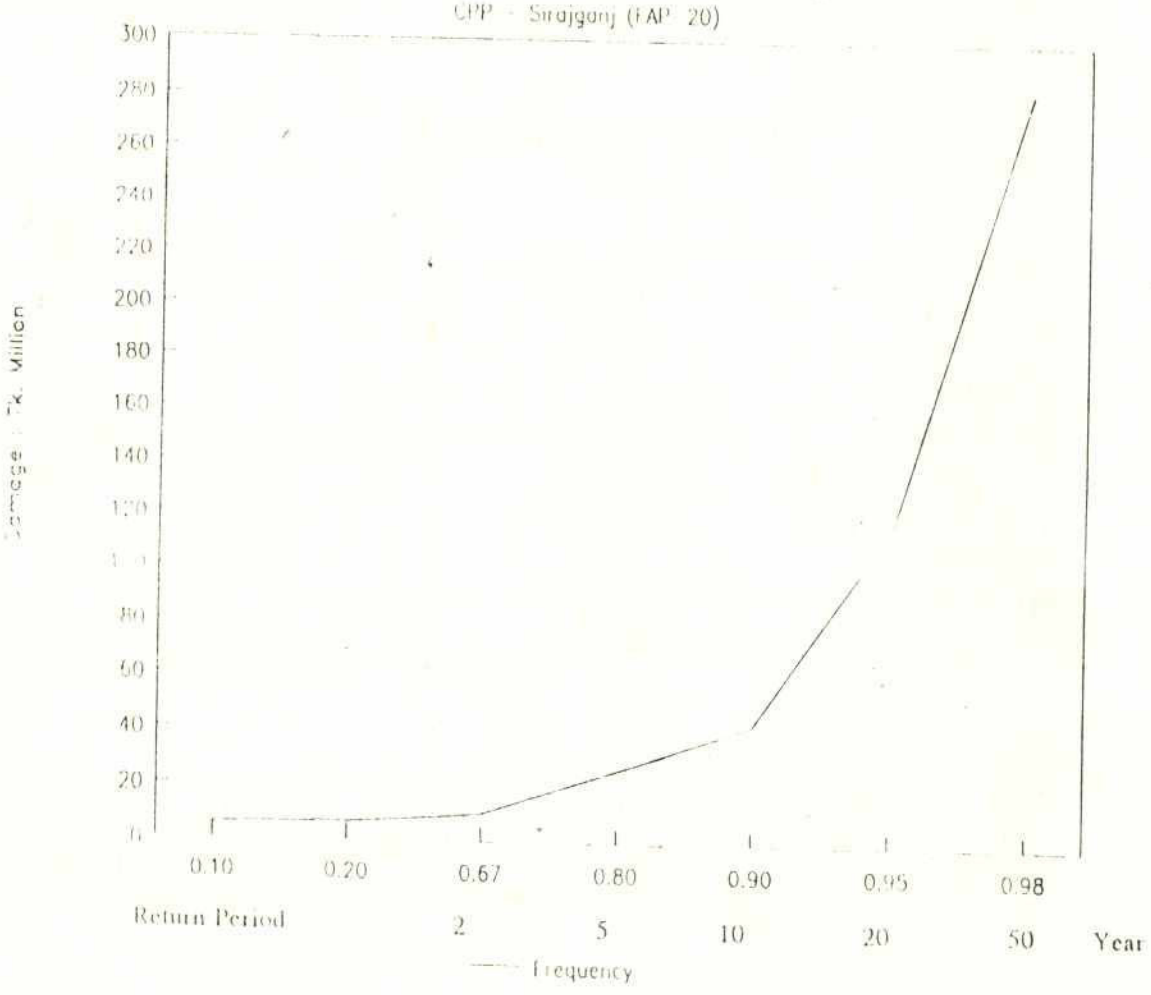
Table 8.4 : Flood Frequencies and Damages in CPP

Return Period (Years)	Reference water level (1)	Freq.	Damage Mill.(Tk)	Added Freq.	Mean Damage Mill (Tk)	Weighted Damage Mill.(Tk)	Yearly prevented damage Mill.(Tk)
1.1	13.62	0.10	5.60	0.10	2.80	0.30	0.3
1.3	13.80	0.20	6.10	0.10	5.90	0.60	0.9
3.0	14.80	0.67	9.80	0.47	8.00	3.70	4.6
5.0	15.31	0.80	26.20	0.13	18.00	2.30	6.9
10.0	15.86	0.90	42.80	0.10	34.50	3.40	10.4
20.0	16.33	0.95	115.10	0.05	79.00	3.90	14.3
50.0	17.10	0.98	282.60	0.03	198.90	5.40	19.7

Source : Computation based on Sirajganj Thana Level Data

(1) Dhunot Station

Figure 8.1 : Damage - Frequency Curve



Damage based on (adapted) official data

The damage frequency curve and the generated values in estimating flood damages prevented is presented in Table 8.4 and Figure 8.1. One aditional difficulty applies for damage assessement in the Sirajganj project area. Under the assumption that the BRE will be repaired and maintained correctly in the future, no breaches will furthermore occur (no guarantee !). In that case only damages of floods caused by excessive rainfall per unit of time may be taken into consideration. On the other hand, if breaches of the BRE will still happen and this even within the reach of the project area than catastrophic damages may be the result, even beyond the level of the disastrous floods experienced so far.

The method used is proposed by the FAP guideline on economic impact assessement. In view to damage prevention only flood conditions caused by breaches of the BRE outside the project area have been taken into account. The total damage believed to be prevented through project activities amounts to Tk mln. 6.9 per year in financial terms and Tk 6.0 mln. in economic terms (SCF = 0.87). Divided into the most outstanding areas affected the following distinction, can be made:

Public physical infrastructure	:	Tk mln.	3.6
Private property	:	Tk mln.	0.5
Crop damage	:	Tk mln.	2.9

Damage caused both to the private and the public sector during prolonged flood periods because of interrupted communication and production processes, have not been considered. In this context it should, however, be mentioned that experience shows that economic losses, at least to the private sector, during flood periods are being set off through increased activities in post-flood periods.

8.2.7 Non-structural measures

Non-structural measures are believed to be vital for the success of the project, including training for both, participants in project activities on beneficiary level and various personnel on staff level. The rationale for using non-structural measures as indicator in impact assessement is that with growing dependancy of objective achievement on institutional requirements and interdepartmental cooperation, higher the risk may be for failure. Information on type of non structural measures and corresponding costs have been given in Annex 7. The estimated cost is Tk 9.5 million for each option.

8.3 Qualitative judgement

Where possible, objectively verifiable indicators have been applied to underline the findings on non quantifiable impacts on fields vital for comprehensive evaluation of expected impacts (See Table 8.2).

8.3.1 Natural Resources and Environment

Flood plain nutrient recharge

Option 2 A and 2 B will actually impede the flooding hazard from the *Jamuna* and the *Ichamati* River/khal and the nutrients will enter the compartment area only in a controlled way, expectedly much less than before the compartmentalization, when breaches were common.

Flood plain sand deposits

The floodplain deposits are expected to decrease in option 2A and 2B. In other words, unwanted sand deposits will be prevented from entering into the compartment.

Waterway sedimentation

Waterway sedimentation means the sedimentation in the drainage system, excluding the Ichamati river. All options have in common that they have a drainage component with which drainage channels will be excavated. After excavation a time lapse will occur from the moment of excavation, until a new equilibrium is established between drainage gradient and suspended load. This initial phase will probably cause sedimentation in the lower sections of the Sub Compartments. Compartmentalization will reduce in principle erosion and thus also sedimentation in a stable hydrological setting.

Groundwater availability

Significant changes in groundwater availability in this area have not been found. It is expected, however, that groundwater availability will decrease due to dry season cropping in an increased rate, coupled with possible reduced recharge.

Surfacewater quantitity

Surfacewater quantity is restricted in options 2 A and 2 B. However, it should be taken into account that:

- a BRE breach is still possible within a certain time span; and
- the BRE inlet structures will provide a considerable amount of water.

Surfacewater quality

The quality of water for Sirajganj town will certainly improve, due to the proposed inlet structure to regulate flood waters according to desired objectives (flushing of the internal canal system). There is no difference between the options as all of them will provide the structural conditions (regulator) required.

Environmental factors

Flora and fauna diversity, wetland and common resources availability are expected to decrease. The decrease will be marginal for Option 1, but substantial for Option 2B.

8.3.2 Agriculture

Dependency on agricultural services

Dependency on agricultual services may be evaluated - especially in economies where agricultural production is based predominantly on subsistence criteria - on the ratio of local varieties to HYV. The latter, no doubt, needing complementary services to take full advantage of the higher genetic potential of improved seeds.

A development towards higher usage of HYV will certainly increase the dependancy on supporting services like improved marketing, efficient input supply systems and competent extension services in addition to the provision of sufficient agricultural credit.

When HYV crops are grown, seeds come more often from farmers' own resources and from neighbours than from any other source. The quality of the HYV seed is not maintained. This holds true especially for marginal and small farmers, because of a mere lack of funds.

Chemical plant protection is still of minor importance. Pesticides and fungicides may, however, have to be used more frequently in coming years as the expected intensification will include increasingly HYV.

Basically, the required fertilizers are available throughout the project area, sometimes on a credit voucher system, giving part of the crop loan in kind (fertilizer). It can be maintained that the system is functional, it is, however, far from being optimal.

The majority of farmers in the project area will by no means be able to cope with these challenges on their own. Development will have to be accompanied by an intensification of agricultural support services, including improved institutional support. It should clearly be understood that, for yet a long time to come, this support will continue to be mainly a public sector responsibility (which is not necessarily a component in compartmentalization).

Seasonal distribution of agricultural labour

In estimating the impact of the seasonal distribution of agricultural labour, the ratio of HYV Boro rice to T. Aman rice has been used. At present this ratio is given with 1 : 0.90. In future developments with project the ratio may be in:

Option 1 :	1 : 0.92
Option 2A :	1 : 1.09
Option 2B :	1 : 1.05.

A higher proportion of aman rice is believed to have positive impact on the quality of cultivation practises as it reduces the stress of high labour peaks during the boro season. The negative impact this may have on reduced labour opportunities for hired labour has not been quantified and will thus not be considered in the evaluation of this indicator.

Livestock

Shortage of fodder is the major constraint for livestock development. As far as cattle is concerned the deterrents identified most of all may be yet a further reduction of green fodder and a deterioration of the quality of straw (HYV).

Poultry activities, on the contrary, may expand, mostly because of their suitabilty for production systems adaptable to small and even marginal farmers. This development will further be stimulated by increasing availability of crop residues especially as feed for poultry, through growing rice production.

As to the future development of sheep and goats, general trends point towards increasing populations, influenced by apparently lower risks involved for losses during abnormal floods. This, however, is independent of improved water management.

The situation described, as well as the scarcity of reliable data in combination with the little quantifiable impact on future livestock activities, a decision has been made not to attempt a quantification in monetary terms at present.

Soil fertility

An adequate indicator towards changing soil fertility conditions may be the ratio of rice to non-rice crops. This ratio has already been presented under "Diversification" above.

The expected development of this ratio does indicate that it will help to stop decreasing soil fertility caused by the present over-dependance on rice-based cropping patterns, which already now demand increasing fertilizer rates only to maintain the present yield levels.

If a more secure environment is felt by the farmers due to reduced flood hazards, natural risk aversion especially of marginal farmers may be reduced in favour of better use of modern inputs. This will also contribute to reduce soil depletion.

The use of fertilizer itself seems also not to be very efficient. The over-emphasis on urea neglects the fact that types and doses of fertilizer have to match the specific properties of different soils as well as the specific demand of crops. Research has proven that substantial improvements in yields are possible only by applying the balanced needs of specific crops on specific soils. The advantage of the low price per Kg pure nutrient in locally preferred fertilizer (Urea, TSP, MP) will definitely be wasted if unbalanced fertilizer doses are applied.

Homestead gardening

Generally the impact of compartmentalization on homestead gardening is not as obvious as may be expected. Damages of lower floods are apparently being regarded by the population as of lesser importance. The impact could, of course, be boosted by adequate "enhancement programmes". Those, however, would neither be mitigation measures nor components of compartmentalization.

8.3.3 Fisheries

Nutritional impact

Due to the conditions established in the Sirajganj area since the completion of the BRE, beel and floodplain fisheries have suffered almost to the extent of negligeble catch levels at present. These conditions will not substantially be improved. Only in option 1 the general impact on improved nutritional standards, if compared to the development without project, will be negative.

Fish recruitement

The impact in view to fish recruitement, a vital precondition for the revival of fishery activities may be regarded more optimistically as the impact on nutrition on subsistence level due to improved floodwater conditions from the *Jamuna*. The corresponding impact in option 2 B being the exception as the fish nursing areas of the Ichamati floodplain will be irreversibly destroyed.

8.3.4 Women

Additional work load

The increased production of rice will need to be processed, the major part of which is done by family labour, in particular by women. This additional work comes in addition to the already high work load of women, and thus increases that work load. Most work will be done by women of the farm households themselves, even though a small part may be done by women hired in by these households.

As women of the farm households are unlikely to receive any additional payment either in cash or in kind, this additional work load is considered to be a negative impact of the project. Those women who are hired-in would benefit from the additional rice production. However, as their number will be relatively small, the balanced impact on women is considered to be negatively correlated to intensified agricultural activities.

Social mobility

By their involvement in female Landless Contracting Societies women will be able to earn a living by working outside their traditional domain, ie. their homes. Through this they

will also become more acquainted with the outside world and other families. Women will become more confident in their abilities.

Through their involvement in Water User Groups, Sub-compartmental Water Management Committees and the Compartment Water Management Committee, women will be able to extend their influence on society and on the direction of their own lives.

8.3.5 Communication

Road transport

The development of existing and additional roads, including culverts, regulators and bridges is likely to have a considerable positive effect on communication. This in turn will facilitate overall mobility, access to inputs and will thus improve marketing conditions of local produce. All of these are considered to have a positive impact which is related to the number of roads developed.

Internal Navigation

At present most channels are silted up and internal navigation is minimal. Compartmentalization involves re-excavating of many channels, which would have a positive impact. On the other hand many more culverts and regulators will be built in these channels. Overall, both impacts are likely to balance each other out.

8.3.6 Health

Nutrition

Impacts of compartmentalization on health are difficult to predict. One reason is that many factors influence health (calory intake, nutritional variety, protein intake, drinking water etc.), and these in turn are affected by compartmentalization in different ways. Also the impact on the different sections of society differs; farm households will no doubt have more rice, but landless households may not. Studies of existing Flood Control and Drainage projects (FCD), - see FAP 16 - have not been able to document either a positive or negative correlation between health and FCD.

However, as expansion of non-rice crops is expected to take place in the region under "with-project" conditions, the project will improve nutritional standards for the population (in addition to increased availability of fodder for livestock). Consequently, there will be the possibility for a more balanced provision of protein by a diversified supply of proteins of vegetative origin.

The additional production of protein of animal origin will especially benefit the poorer section of the population. Through enhancement of capture fishery and through transfer of knowledge the impact on health could be made more positive.

Domestic water supply

To the extent that compartmentalization allows for flushing of stagnant water bodies, the impact is considered to be positive. To the extent that flooding itself will be limited, and therefore the water table reduced, domestic water supply may suffer. On balance the two are likely to balance each other.

Vector-borne and water related diseases

Impact on public health is probably balanced, although there is a potential for improvements if mitigation measures and associated, integrated water management and public health programmes are introduced.

Risks associated with vector borne diseases can slightly increase (Kala-azar) or decrease (Malaria). However, major changes in environmental receptivity and community vulnerability are unlikely to occur due to CPP activities.

Other water-related communicable diseases are prevalent especially during the flood season. There is a potential for environmental management and manipulation, such as controlled overland flow, water level manipulation in polluted water bodies and flushing of stagnant water bodies and Khals. Controlled flooding will also have options for associated public health developments as for instance improved sanitation and habitation, access to safe drinking water during floods and solid waste disposal systems.

Risks associated with polluted water and soil and hazardous materials may increase in both, urban and rural areas, due to agricultural and industrial/commercial developments.

8.3.7 Institutions

Institutional requirements on local level

The more regulating facilities a compartment has, the more difficult it will be to manage. The same applies to compartments that are designed in such a way that different interest groups would want a different kind of operation. Examples of the first point are a series of regulators that need coordinated operation to achieve the desired effect. An example of the latter are conflicts between those living inside and outside the compartment in case of a breach of the BRE to the North of the compartment.

In the case of the various options the internal arrangements are similar, so the difficulty on that score is the same. The institutional requirements needed to manage compartments are also considerable. A conflict with the people on the right bank of the Ichamati river will arise in case the Ichamati left embankment is built. People from that area have already expressed their fears in this respect. Option 2B has that embankment close to the river, which will worsen the effect on the right bank.

To facilitate the necessary cooperation and coordination, an extensive programme has been designed to organise Water Users Groups, form Sub-Compartmental Water

Management Committees and a Compartment Water Management Committee. These efforts are designed to provide the necessary institutional structure, and are likely to at least partly meet the required level of cooperation.

Interdepartmental dependency

Increased overall economic activities require inputs from various sides (credit, HYV seeds, pesticides, fertilizers, fish fry, marketing facilities etc.). To raise the already reasonably high level of production all relevant departments will have to coordinate their activities and play their respective role for the intended benefits to materialize.

To enhance the necessary interdepartmental cooperation an intensive programme has been worked out. At implementation level this involves an Extended Project Team in which Thana level officers are involved. At district level a steering committee will be organised allowing all relevant departments a chance for active involvement in compartmentalization. Therefore the affect of mitigation is rated positive.

8.3.8 Social Issues

Social conflict

Additional facilities to manage water may lead to conflicts between the different interest groups. An attempt has been made to design the structures in such a way as to minimize extreme usage (for instance, prevent complete drainage of a beel).

Furthermore, operational rules will be set to do the same (gates to be left open till July 15 to allow fish-fry entry). Finally the provision of institutional facilities is expected to be able to solve most of the conflicts.

Income distribution

Studies in Bangladesh have shown that small and marginal farmers are the highest adopters of HYVs. In principle, they are expected to have access to the benefits from compartmentalization. On the other hand availability of credit is crucial. To the extent that farmers have to rely on non-institutional credit (moneylenders), much of the benefit from growing HYVs is likely to end up in the hands of moneylenders. If institutional credit were available, this could be partly mitigated (not included in the project plan). Given the existing social structure, on balance the income distribution among different groups of farm households is likely to be disproportionate, though almost all are likely to benefit.

Landless are likely to only benefit indirectly from increased agricultural production. Given the percentage of small and marginal farm households, most additional labour is likely to come from within those households themselves. Therefore only a marginal part of the additional labour requirement is likely to be provided by landless households. They will however benefit indirectly from forward and backward linkages of overall

agricultural growth. Income distribution between farm and non-farm households is always negatively correlated with increased agricultural production.

As a compensation/mitigation measure during the time of constructing the compartment, earth moving work will be awarded to Landless Contracting Societies (LCSs). After construction all earth-work, maintenance work will be awarded to Embankment Maintenance Groups. These provisions will positively affect income distribution.

8.3.9 Others

Flood retention

From a compartmental point of view, flood retention is likely to limit the damage to a smaller area, and thus be beneficial. This may contribute however, to the social conflicts mentioned above. On balance, flood retention is likely to have an overall positive impact.

Cultural heritage

To the extent that compartmentalization will limit the effect of breaches it is likely to have a minor positive effect on cultural heritage such as the Sirajganj Ghat Temple.

8.4 Conclusions

The future situation with project compares favourably with the present situation for all options evaluated in terms of overall cropped area, cropping intensity and production. All corresponding figures have been presented in detail in Annex 9. They are summarized below as follows:

Option	Cropped area ha	Cropping intensity %	Additional Production Tk mln./year
Base situation	17,670	184	
Future "without"	17,925	187	5.63
Option 1	18,323	191	22.61
Option 2A	19,670	205	58.81
Option 2B	19,760	206	63.65

Above figures clearly show the comparative advantage of options 2A and 2B, which is explained almost exclusively by the change in cropped area. Additional areas in comparison to the anticipated area in the development without project are for:

Option 1 : 398 Ha
Option 2A: 1,745 Ha
Option 2B: 1,835 Ha

Those developments are based on the simulated waterlevels as well as underlying assumptions are explained in Annex 4.

If a more secure environment is felt by the farmers due to reduced flood hazards and improved water management, natural risk aversion, especially of marginal and small farmers may be reduced in favour of increased and more efficient cultivation practices. To justify the increase in cropped area in option 2A and 2B, however, it is stressed again that substantial institutional support has been included.

Intensified agricultural activities will of course generate additional employment opportunities. These have been identified to be 126000 man days per year for option-1, 372000 and 397000 man days per year for option 2A and 2B respectively. Outside agricultural activities, new jobs will also be created in connection with operation and maintenance requirements of the water management system.

The global impact on production per option is given below concentrating on additional production per option of only rice and non rice crops, all corrected by "with-out project" figures:

	Additional production (MT/year)	
	Rice	Non-rice crops
Option 1	8000	11100
Option 2A	10700	19600
Option 2B	10900	23900

Other criteria also point towards a positive impact in agricultural development as has been shown in the corresponding criteria (HYV to local varieties ratio, non-rice crops to rice crops, seasonal labour distribution, soil fertility) evaluated and summarized in Table 8.1. Growing dependancy on agricultural services (extension service, input supply system, marketing, agricultural credit) may put this at stake if the required support remains on the presently low level.

The development in fisheries activities may be regarded as having a sightly negative impact, especially as for option 2B, due to the destruction of some of the nursing area for fish.

Additional negative impact, expressed as costs in monetary terms, will have to be considered as well. Those are costs for land aquisition (in financial evaluation only, based on BWDB standards of 150,000 Tk per Ha) and production foregone, based on area lost multiplied by the value added for the present situation (assuming 80% of the corresponding area being used). Total costs are recapitulated below (in financial terms):

	Area lost ha	Land aquisition Tk mln.	Production foregone Tk mln./year
Option 1	0	0	0
Option 2A	56	20.7	1.1
Option 2B	100	37.1	1.9

Costs for land acquisition will have to be paid in the first year of implementation. They do not include any provisions for administrative costs surely involved in the identification of the persons entitled and the disbursement of the compensatory payments.

It has been assumed that full benefit development will be achieved in year twelve of the project or, more precisely, ten years after the implementation of the major components.

Indirect benefits may accrue in form of farmers contribution in money or kind to pay, at least part of the O & M costs. Without yet precise information on the determination of those contributions, they have been assumed to be 5 % of recurrent costs, equal to about Tk mln. 0.5, 0.8 and 0.85 per year for option 1, 2A and 2B respectively. As they must be regarded as transfer payments, they will not be considered in the economic evaluation.

Additional indirect benefits have been included to opt for any benefits not or not yet quantifiable in monetary terms. A rate of 5 % of compounded benefits is regarded as justifiable for this purpose.

No attempt has been undertaken to quantify the impact the project may have on income distribution. It has been concluded that as the data are now being generated on the exact family composition per group, their specific social or economic parameters (cultivation practices, nutritional requirements for the family, literacy rates, repayment capacities, degree of mechanization, marketing rates for their produce, personal preferences), no attempt is made to draw conclusive results. This however, will be done in the final evaluation.

Based on the analysis of primarily the direct impacts which may be quantified in monetary terms, Option 1 is not justified and Options 2A and 2b are justified in economic terms. The corresponding figures are presented below:

Option	EIRR %	NPV (Tk mln.)
Option 1	5.9	-73.4
Option 2A	15.7	56.6
Option 2B	15.2	51.5

However, it must be added here, that no attempt has been made to quantify the impact of the Sirajganj compartment on adjacent areas. In the final economic analysis, however, those impacts must be quantified.

It should be expected that major justification for flood protection and improved water management should come from damage prevention. The outcome here proves that in spite of realistic figures on damage prevention substantially higher impact originates from incremental agricultural benefits. This may partly be explained by the high development potential of the Sirajganj area, starting from a relatively lower degree of agricultural development (cropping intensity of 184 % at present).

It should, however, be kept in mind that in general there are many reasons for a region to be economically less developed compared to others. In Sirajganj area this may have been the insecure flooding conditions due to frequent and erratic breaches of the BRE. It would be interesting to know, how much of the predicted agricultural development may actually be attributed to an improved and secure BRE, excluding future breaches.

A sensitivity analysis (examplified on option 2A as the most promising) based on variations of areas, yields and shorter development periods for benefits to reach final values, show a significant impact, as summarized overleaf:

	Variation	EIRR % 10 years
Base case (Option 2A)		15.7
Recurrent cost of Tk 4 mln extra for supporting services		13.6
Reduction of yields of	10%	12.0
	20%	8.1
Reduction of cropped area of	10%	13.9
	20%	12.1
Reduction of cropped area (10%) and yields (10%)		10.3
Reduction of cropped area (10%) and yields (20%)		6.4
Achievement of full agricultural benefits in 5 years		18.1

"5 years" and "10 years" refer to the period assumed necessary to achieve full agricultural benefits. In the base case, a period of 10 years has been assumed.

The variables tested, clearly indicate a marked reaction of all economic parameters (here examplified by the EIRR) on a reduction of the cropped area, but a significantly higher sensitivity on changes in yields. Assuming that only 80 % of the assumed increase in yields may actually be attributable to compartmentalization, (the remaining benefits being due to changed conditions which would result from an improved BRE), the economic viability of the Sirajganj CPP would be lower accordingly.

On the other hand, the combined effect of increasing yields and a growing cropping intensity (increase in cropped area) would yield markedly higher benefits, as can be seen if a shorter period is assumed to achieve full agricultural benefits.

As the main objective of this chapter was to elaborate primarily a multi-criteria analysis, less importanee has been accorded to analyse the influence of an improved BRE. This will be left for the final economic analysis.

One more point is of interest. The mathematical model used to simulate external flooding patterns and their hydrological consequences for the compartment is not yet suffiently

refined to allow precise enough simulations of internal water conditions on sub-compartments. The additional influence of structures designed partly for internal control can thus not be accurately determined at present.

Finally, it is common understanding that the programme under dicussion here is oriented on the total floodplain and can consequently not be judged by economic criteria alone. Other factors, possibly producing desireable impacts in fields not to be quantified by monetary standards, have been identified, analyzed and included in the final judgement.

For instance, in spite of the generally favourable outcome of at least options 2A and 2B and some tangible benefits especially in favour of the section of the population most urgently in need of support, final success will greatly depend on active involvement of the population. This has to be kept in mind when participation of the population is asked for not only in activities directly related to project activities (water user groups and committees), but in view to further agricultural development. The majority of the population concerned will depend on adequate and effective institutional support in order to allow the projected development.

Considering the outcome of the multi-criteria analysis at this stage, no definite recommendation can be made as to the final selection of one particular development option. It is clear, however, that Options 2A and 2B are preferable to Option 1. It is therefore proposed to carry out additional consultations and analyses to determine the comparative advantages of Options 2A and 2B. The result might very well be, that the optimum solution will turn out to be a combination of both options. The outcome, however, does not interfere with the proposed implementation schedule.